Chapter Three: Facility Requirements and Alternative Development

1.0 General

The previous two chapters (*Chapter 1 – Inventory* and *Chapter 2 – Aviation Demand Forecasts*) identify the airports existing facilities and provide a 20-year projection of aviation activity for Concord Municipal Airport. The information provided in those chapters serves as the foundation for this and subsequent chapters.

Note that the New Hampshire Army National Guard is responsible for future development and maintenance of their facilities within their leased area. Although their operational facilities are identified within previous chapters, they will not be analyzed within this chapter or as part of this airport master plan update.

The purpose of this chapter is to use the data collected within the inventory and aviation forecast chapters to: 1) determine the adequacy of the existing airport facilities; 2) determine if the facilities at Concord Municipal Airport can accommodate the projected planning activity levels; 3) determine if the existing and future airport facilities do meet, or can meet, Federal Aviation Administration (FAA) airport design criteria; and 4) determine the best method, or alternative design option, for future airport development.

This chapter did not focus on theoretical runway capacity levels as calculated in the FAA Capacity Manual as operational capacity is not an issue at current and future operations levels.

The following known airport issues and/or development needs were identified during the initial airport master plan update meeting (held on October 7, 2004):

- Identify issues and/or impacts associated with wildlife/security fence installation (enclose the airport operations area) and make recommendations for wildlife/security fence completion;
- Construct a perimeter road;
- Calculate existing and future snow removal building and equipment needs;
- Identify the pavement condition of all runways, taxiways and ramps and make recommendations for pavement rehabilitation;
- Identify existing and potential land use conflicts and make recommendations for improvements;
- Identify airport obstructions and make recommendations for removal and/or obstruction lighting;
- Identify obstructions within the approach for Runway 17-35 – it is possible that the visibility minimums could be reduced if the obstructions were removed;
- Assess aircraft storage requirements (hangars and tie-downs) during both peak activity demand and typical airport use;
- Analyze typical airport users and make recommendations for the establishment of future facilities to accommodate those users;
- Review existing airport navigational and visual aids and make recommendations for improvement;
- Analyze the need for an extension to Runway 17-35;
- Make recommendations to improve runway and taxiway signs, lighting and markings. They currently are in poor condition;
- Analyze the need for a parallel taxiway to Runway 12-30;

- Provide alternatives and recommendations for improvement for the confusing intersection at the approach ends of Runways 17 and 12;
- Make recommendations to improve automobile parking requirements during peak activity;
- Assess converting the old, closed runway, Runway 03-21, into a taxiway/ramp;
- Review terminal building reconstruction and/or upgrades and terminal building location/relocation options;
    - Assess the possibility of a joint use terminal building facility with the Concord Heights Fire Station;
- Assess fuel facility requirements and the potential need for an additional 18,000-gallon underground Jet A fuel storage tank; and
- Evaluate the current airport management system and make recommendations for improvement

Recommendations made within this chapter address the known issues and/or development needs listed above with the exception of the potential land use conflicts, which are covered in more detail in *Chapter 4 – Environmental Review* and the evaluation of the current airport management system, which is covered in *Chapter 6 – Capital Improvement Plan & Airport Operations/Finances*.

Any potential environmental impacts associated with the following recommendations for improvement are outlined in *Chapter 4 – Environmental Review*, while a graphic depiction of the proposed development is shown in *Chapter 5 – Airport Plans* of this report.

Construction cost estimates for future development are provided in *Chapter 6 – Capital Improvement Plan & Airport Operations/Finances*.

1.1 Previous Airport Master Plan Update Recommendations

In the context of a master plan update, it is necessary to compare prior facility recommendations and analyze what has been implemented before updating the current needs. Recommendations made in the *March 1996 Concord Municipal Airport Master Plan Update* to meet deficiencies found at Concord Municipal Airport are presented in *Chapter 1 – Inventory*, Table 1-4. Projects not completed since the 1996 recommendations are depicted below in **Table 3-1**.

Table 3-1: March 1996 Airport Master Plan Update - Projects Recommended/Not Completed

Rehabilitate the existing terminal building
Construct a parallel taxiway to Runway 12-30
Convert the closed Runway 03-21 to a taxiway
Extend Canterbury Road
Purchase avigation easements and properties located within the runway protection zones (RPZs)
Complete an obstruction study for all approaches
Abandon Canterbury Road and assemble a development parcel

The projects listed above, or some variation thereof, continue to be recommended, as detailed in subsequent sections of this chapter. However, the following exceptions apply:

- The Canterbury Road projects (extend and abandon) have been eliminated and will not be carried over into this master plan effort. Discussions with the City of Concord indicate that the Canterbury Road projects were abandoned during the Regional Drive extension project.

Some, but not all, of the recommended avigation easements have been purchased.

An obstruction study of the runway approaches is being completed concurrently with this master plan update.

The following elements are examined within this chapter:

- ***Development Considerations***
  - Protected Surfaces
    - Airport Design Criteria
    - Navigational Aid Critical Areas
    - Imaginary Surfaces
    - The Runway Visibility Zone
  - Existing Terrain
  - Environmentally Sensitive Areas
- ***Landside Facility Requirements and Alternative Development***
  - Aircraft Storage
  - Automobile Storage
  - Terminal Building Disposition
  - Aircraft Fuel Facility
- ***Airside Facility Requirements and Alternative Development***
  - Runways
  - Taxiways
  - Pavement Condition
  - Visual and Navigational Aids
    - Marking, Lighting, Signs and Navaids
  - Airside Obstructions/Imaginary Surfaces
- ***Storm Water Pollution and Prevention Plan***
- ***Airport Wildlife/Security Fencing Requirements***
- ***Airport Perimeter Road Requirements***
- ***Snow Removal Equipment Requirements***

2.0 Development Considerations – Protected Surfaces

The primary goals of an airport manager/owner are the safe and efficient operation of the airport and the design and development of that airport to satisfy local, regional or national aviation needs. To improve safety at our nation's airports, Federal regulations and standards exist that regulate airport design, development and maintenance. Those standards identify areas, both on and off of airport owned property, that are to be protected and maintained for the safety of the flying public. Those protected surfaces surround runways, taxiways, navigational aids and the airspace above airports. The following are examined:

- Airport Design Criteria;
- Navigational Aid Critical Areas;
- Imaginary Surfaces; and
- The Runway Visibility Zone

Future development must consider these protected surfaces when making recommendations for improvement and prior to the implementation of new or improved facilities.

2.1 Protected Surfaces - Airport Design Criteria

In an effort to identify the adequacy of existing airport facilities and land availability for future airport development, the ultimate airport design criteria must first be determined.

Airport development and design is based upon the types of aircraft, or the most demanding aircraft group, expected to use the airport facility on a regular basis (a regular basis is considered at least 500 annual operations). The FAA has established the Airport Reference Code (ARC) as the method of determining airport design. The ARC is an alphanumeric code based on the approach speed (alpha) and wingspan length (numeric) of the critical aircraft, or most demanding aircraft or aircraft group using the airport on a regular basis. The ARC outlines the dimensional design requirements such as length and width for runways and taxiways and their associated protected surfaces such as safety areas and safety zones. The higher the alphanumeric code, the more stringent the design criteria. The existing ARC for Concord Municipal Airport is B-II for both Runways 17-35 and 12-30. Category B is for aircraft with approach speeds of 91 knots or more but less than 121 knots and group II is for aircraft with wingspans of at least 49 feet up to but not including 79 feet.

Discussions with airport tenants, airport users, the New Hampshire Department of Transportation (NHDOT) and the FAA identified the need to analyze the merits and limitations of implementing more stringent design criteria such as C-II design criteria for Runway 17-35, only. To do so, the following analysis is required: 1) we must first identify whether or not future C-II design criteria can be reasonably met at Concord Municipal Airport; and 2) we must determine if the future C-II design criteria would adversely impact existing facilities, the environment or future airport development plans.

Table 3-2 below identifies Concord Municipal Airport's existing B-II design criteria for both Runways 17-35 and 12-30 and potential C-II design criteria for Runway 17-35, only. The ***bold and italicized*** dimensions depicted in the table identify C-II design criteria that either cannot be met due to existing conditions and/or runway and taxiway configuration, or can be met, but with difficulty.

Table 3-2: Airport Design Criteria (Existing B-II and Potential C-II for Runway 17-35)

Design Elements	Design Criteria (feet unless otherwise indicated)					
	Existing Design Criteria Runway 17-35 and Existing and Future Design Criteria Runway 12-30				Potential Design Criteria Runway 17-35 Only	
	B-II				C-II	
	Visibility not lower than ¾-mile				Visibility lower than ¾-mile [1]	
Runway	Runway 17-35		Runway 12-30		Runway 17-35	
	17	35	12	30	17	35
Runway Protection Zone:						
Length	1,000	1,700	1,000	1,000	***1,700***	***2,500***
Inner Width	500	1,000	500	500	***500***	***1,000***
Outer Width	700	1,510	700	700	***1,010***	***1,750***
Total Acreage	13.770	48.978	13.770	13.770	***29.465***	***78.914***
Runway Width:						
Required Runway Width (actual)	75' (100')		75' (75')		100' (100')	
Runway Shoulder:						
Required width (actual)	10' (10'+)	10' (10'+)	10' (10'+)	10' (10'+)	10' (10'+)	10' (10'+)
Runway Blast Pad:						
Required length beyond runway end (actual)	150' (150'+)	150' (150'+)	150' (150'+)	150' (150'+)	150' (150'+)	150' (150'+)
Required width beyond runway end (actual)	95' (95'+)	95' (95'+)	95' (95'+)	95' (95'+)	120' (120'+)	120' (120'+)
Runway Safety Area:						
Required length prior to landing threshold (actual)	300' (300'+)	300' (300'+)	300' (300'+)	300' (300'+)	600' (600'+)	600' (600'+)
Required length beyond runway end (actual)	300' (300'+)	300' (300'+)	300' (300'+)	300' (300'+)	1,000' ***(400')***	1,000' (1,000')
Required width (actual)	150' (150'+)	150' (150'+)	150' (150'+)	150' (150'+)	400' or 500' [2] (500')	400' or 500' [2] (500')
Runway Object Free Area:						
Required length beyond runway end (actual)	300' (300'+)	300' (300'+)	300' (300'+)	300' (300'+)	1,000' ***(400')***	1,000' (1,000')
Required width (actual)	500' (500')	500' (500')	500' (500'+)	500' (500'+)	800' (800')	800' ***(500')***
Runway Obstacle Free Zone:						
Required length beyond runway end (actual)	200' (200'+)	200' (200'+)	200' (200'+)	200' (200'+)	200' (200'+)	200' (200'+)
Required width (actual)	400' (400'+)	400' (400'+)	400' (400'+)	400' (400'+)	400' (400'+)	400' (400'+)
Required inner-approach OFZ length (actual) [3 & 4]	N/A	2,600' (2,600')	N/A	N/A	N/A	2,600' (2,600')
Required inner-approach OFZ width (actual) [3]	N/A	500' (500')	N/A	N/A	N/A	800' ***(500')***
Required inner-approach OFZ Slope (actual) [3 & 5]	N/A	50:1 (34:1)	N/A	N/A	N/A	50:1 ***(34:1)***
Required inner-transitional OFZ (actual) [6]	N/A	N/A	N/A	N/A	N/A	See note 6

Table 3-2 Continued

Taxiway:		
Width (actual)	35' (50')	35' (50')
Taxiway Edge Safety Margin (actual)	7.5' (7.5')	7.5' (7.5')
Taxiway Shoulder Width (actual)	10' (10')	10' (10')
Taxiway Safety Area Width (actual)	79' (79')	79' (79')
Taxiway Object Free Area Width (actual)	131' (131')	131' (131')
Runway Separation Standards:	**Visual runways/runways with not lower than ¾-statute mile approach visibility minimums**	**Runways with lower than ¾-statute mile approach visibility minimums**
Runway centerline to taxiway/taxilane centerline (actual)	240' (400')	400' (400')
Runway centerline to aircraft parking area (actual)	250' (500)'	500' (500')

Notes:

1. According to discussions with the FAA, there are approach obstructions (trees) located within the approach of both Runway 17 and 35, which restricts the runways visibility minimums to greater than ¾ of a mile. Although this master plan update recommends the removal of those obstructions to allow for lower visibility minimums, the FAA must ultimately determine the visibility minimums that can reasonably be met and should be contacted so that an analysis can be conducted. The C-II design criteria listed reflects the criteria based on the lowest possible visibility minimums, lower than ¾-mile.
2. According to *Advisory Circular (AC) 150/5300-13, Airport Design*, for ARC C-I and C-II, a runway safety area width of either 400 feet or 500 feet is permissible.
3. The inner approach OFZ (length, width and slope) applies only to Runway 35 at Concord Municipal Airport.
4. The inner approach OFZ length extends 200 feet beyond the last approach light system (ALS) light unit. The Medium Intensity Approach Light System with Runway Alignment Indicator Lights (MALSR) for Runway 35 extends 2,400 feet beyond the end of the runway threshold; therefore, the inner approach OFZ length is 2,600 feet.
5. A slope of 50 feet horizontally and 1-foot vertically is the required OFZ slope for this design criteria. However, a slope of 34 feet horizontally and 1-foot vertically is widely accepted in the New England area due to the mountainous terrain. However, achievement of the 50:1 slope is desirable.
6. The inner-transitional OFZ applies only to runways with lower than ¾-statute mile approach visibility minimums, such as the potential visibility for Runway 17-35 if obstructions are removed. For Runway 35 (a Category I precision instrument runway), the inner-transitional OFZ begins at the edges of both the runway OFZ and inner-approach OFZ, then rises vertically for a height of 55 feet, and then slopes 6 feet (horizontally) to 1-foot (vertically) out to a height of 150 feet above the established airport elevation (346 feet), or 496 feet.

As indicated by the ***bold and italicized*** dimensions in the table above, the dimensional standards for the runway protection zone (RPZ), runway safety area (RSA), runway object free area (ROFA) and runway obstacle free zone (ROFZ) currently cannot be met. The following defines those design elements and identifies their existing limitations.

The **runway protection zone (RPZ)** is a trapezoidal surface on the ground, centered on the extended runway centerline, and begins 200 feet from the end of usable runway. In *AC 150/5300-13, Airport Design*, the FAA recommends that certain land uses, such as residences and buildings for public assembly, be prohibited from within the RPZ. They also recommend the exclusion of land uses that attract wildlife within the RPZ. If the RPZ surface extends into lands that are not owned by the airport, the FAA recommends that the airport either acquire the property or obtain easements that allow the airport to control the height of objects within the RPZ.

As identified in the table above, an increase in design criteria would also constitute an increase in the dimensional standards for Runway 17-35s RPZ. The RPZ area for Runway 17 would increase by approximately 46 percent (from 13± acres to 29± acres), while the RPZ surface for Runway 35 would increase by approximately 62 percent (from 48± acres to 78± acres).

The runway safety area (RSA) is a graded, rectangular area, centered on the runway centerline, and extended beyond the runway ends and runway edges. The RSA must be cleared, appropriately graded and drained. It must be free of objects, except those that need to be there due to their function, such as navigational aids. It should be capable of supporting airport mobile equipment, rescue equipment, and the occasional passage of aircraft under dry conditions. Any object located within the RSA higher than three inches must be constructed with frangible supports, with the frangible point no higher than three inches above grade. The airport should own the land that constitutes the RSA so that maintenance and the control of objects can be accomplished.

The **runway object free area (ROFA)** requires clearing of above ground objects protruding above the RSA edge elevation, except for navigational aids as mentioned above. Similar to the RSA, the airport should own the land that constitutes the ROFA.

The **runway obstacle free zone (ROFZ)** is a defined volume of airspace centered above the runway centerline. It prohibits taxiing and parked aircraft and requires clearing of object penetrations.

As identified in Table 3-2, an increase in design criteria would also constitute an increase in the dimensional standards of the RSA, ROFA and ROFZ for Runway 17-35. The RSA and ROFA length beyond runway end would increase from its existing required length of 300 feet to a 1,000-foot requirement. Currently, only 400 feet of available airport owned land exists beyond the Runway 17 approach end. Beyond that is the newly constructed Regional Drive as well as several privately owned residential properties. The 1,000-foot standard can be met on Runway 35.

Implementation of C-II design criteria would also increase the ROFA and ROFZ width from a 500-foot requirement (250 feet either side of runway centerline) to an 800-foot requirement (400 feet either side of runway centerline). Currently, only 250 feet on the east side of Runway 35 is available. Beyond that there exist tree obstructions as well as significant terrain issues (for more information see *Section 2.5 – Development Considerations – Existing Terrain* of this chapter or *Chapter 5 – Airport Plans, Drawing 5* for a topographic plan). The full 800-foot width of the ROFA and ROFZ can be met on the Runway 17 end.

Analysis of the C-II design criteria, the limitations that exist, and comparing the two dimensional design standards (B-II versus C-II) identified the following:

1. Increases in the size of the RPZ for Runway 17 would incorporate additional incompatible land uses such as residences and buildings for public assembly. The existing RPZ surface includes approximately 10 residential properties. Increases in design criteria would more than double that amount. The City has plans to either acquire the existing 10 residential properties or obtain avigation easements. However, an upgrade in design criteria would require the City to acquire even more land above and beyond what they have already planned to purchase.
2. Increases in the RPZ dimensions would also adversely impact future off-airport development plans.
    a. The New Hampshire Army National Guard has a facility located off of airport owned property, north of Regional Drive and Runway 17's approach. The Army has both short and long-term plans to expand their existing facilities at this site. Although short-term plans would not be impacted by an increase in RPZ dimensions, it would limit future long-term expansion plans. The larger RPZ for Runway 17 would incorporate an additional 7±-acres of the New Hampshire Army National Guard facility, thus, impacting their long-term future expansion plans, which is undesirable.
3. Increases in the size of the RSA and ROFA may limit future runway length expansion possibilities and would impact existing available runway length. Since the *March 1996 Concord Municipal Airport Master Plan Update*, recommendations have been made to increase Runway 17-35s length on the 35 approach end. The additional length is also recommended within this

master plan update (see *Section 4.1.4 – Runway Issues* of this chapter for further information); however, an increase to C-II design criteria may limit expansion possibilities. Although the airport has the land available to meet C-II RSA and ROFA design criteria on the Runway 35 approach end, they lack available space on the Runway 17 end due to the close proximity of Regional Drive and residential properties. In order to meet the C-II design standards on the Runway 17 end, the airport would have to either use a combination of the existing turf and displaced threshold to meet the 1,000-foot RSA/ROFA standard or relocate the threshold, both of which would decrease the operational lengths available for takeoff and landing. Such outcomes are undesirable since the airport desires more runway length not less. Likewise, a 1,000-foot RSA and ROFA on the Runway 35 end could be met but, depending on the alternative chosen on the Runway 17 approach end, may limit the amount of land available for future expansion on the opposite end.

4. Increases in the RSA and ROFA dimensions would impact the established conservation zones (see *Chapter 4 – Environmental Review* "Conservation Management Agreement" for further information), which have been created for the purpose of managing airport lands that provide essential habitat for the Karner Blue Butterfly, a federally and State listed endangered species. The increase in the dimensional standards for runway safety areas and safety zones would require that more land be cleared, mowed, maintained and graded, thus, impacting the habitat that is being protected.
5. Increases in the ROFA dimensions would preclude full installation of the airport wildlife/security fence. Currently the eastern half of the airport is not fenced. Current B-II design standards allows for full installation (wildlife/security fencing must be placed outside of the ROFA). The C-II standards call for wider ROFA width requirements, which cannot be met on the eastern side of Runway 35 due to significant tree obstructions as well as terrain issues. The significantly sloping terrain makes fence installation extremely difficult, perhaps impossible.
    a. A modification of airport design standards to meet local conditions would be required for the wildlife/security fence installation if C-II design criteria were used.
6. The airport currently can accommodate aircraft that fall into the C-II design category, while functioning as a B-II airport. We assume that this practice will continue in the future. Data collected for the forecast potion of the master plan update *(Chapter 2 – Aviation Demand Forecasts)* indicates that existing and future aircraft operations (as of September 2004) occur with more aircraft that fall into the B-I/B-II airport design criteria. Aircraft with more stringent design standards (C-II, C-III, D-I and D-II criteria) currently utilize the airport; however, with less frequency than B-I/B-II aircraft. Discussions with airport tenants and users indicate that although there are some operations conducted by these larger aircraft, the majority are seasonal operations or operations during peak periods or special events, and would not necessitate a change in ARC at this time.

For these reasons it is recommend that the airport maintain its current status as a B-II airport, thus, subsequent recommendations will abide by those standards.

2.2 Protected Surfaces - Navigational Aid Critical Areas

Runway 17-35 has an instrument landing system (ILS) approach to Runway 35. An ILS typically consists of the following electronic components and visual aids that provide course guidance to the runway in low visibility conditions:

- Localizer
- Glideslope
- Marker Beacons
- Approach Lights

Of those components, the localizer and the glideslope have safety areas, known as critical areas, which surround each piece of electronic equipment. The electronic equipment is susceptible to signal interference from sources such as power lines, fences, metal buildings, aircraft and vehicles. Therefore, those critical areas must be kept free of such objects. ***Section 4.3 – Visual and Navigational Aids*, of this chapter recommends improvements to the airport's visual marking aids to assist in protecting these surfaces.**

2.3 Protected Surfaces - Imaginary Surfaces

Federal Aviation Regulation (FAR) Part 77, *Objects Affecting Navigable Airspace*,[ii] establishes imaginary surfaces above airports to protect navigable airspace from objects/obstructions that may penetrate the airspace. According to Part 77, obstructions are considered to be any manmade objects, objects of natural growth, such as trees or brush, and terrain (ground penetrations) that should be either removed or marked as an obstruction.

The airport's imaginary surfaces are based on the classification of the runway and the type of approach available. Logically, the dimensions of the imaginary surfaces for a precision instrument approach runway (such as Runway 17-35) are larger than those associated with a visual or non-precision runway approach (such as Runway 12-30), to provide greater safety margins for operations in low visibility/instrument conditions.

The following defines the imaginary surfaces that must be protected, while **Table 3-3** depicts the existing and future FAR Part 77 airspace imaginary surfaces for Concord Municipal Airport. **Figures 3-1 and 3-2** provide a graphical depiction of those surfaces.

- **Primary Surface:**
  - A surface centered longitudinally along the runway, which extends 200 feet beyond the paved thresholds. The width is dependent on the type of approach (precision, non-precision, visual, etcetera).
- **Approach Surface:**
  - A surface centered longitudinally on the extended runway centerline. This surface extends upward and outward from each end of the primary surface.
- **Horizontal Surface:**
  - A horizontal plane established 150 feet above the airport elevation. The limit of the horizontal surface is defined by the radius from the center of each end of the primary surface. Tangents connect each radius.
- **Conical Surface:**
  - A surface extending upward and outward from the horizontal surface at a slope of 20 feet horizontally to 1-foot vertically for a distance of 4,000 feet.
- **Transitional Surfaces:**
  - A surface extending outward and upward from the edges of each primary and approach surface at right angles to the runway centerline at a slope of 7 feet horizontally to 1-foot vertically. The transitional surface terminates at the horizontal surface.

Table 3-3: FAR Part 77 Airspace Surfaces – Concord Municipal Airport

Airport Data	Runway 17		Runway 35		Runway 12		Runway 30	
	Existing	**Ultimate**	**Existing**	**Ultimate**	**Existing**	**Ultimate**	**Existing**	**Ultimate**
Runway Classification	Non-Precision Instrument	Same	Precision Instrument	Same	Non-Precision	Same	Visual	Same
Approach	Non-precision	Same	Precision	Same	Non-precision	Same	Visual	Same
Visibility Minimums	1 mile	Same	1 mile	¾ mile	1 mile	Same	3 miles	Same
Airport Elevation (feet)	346							
Airport Imaginary Surfaces	**Existing**	**Ultimate**	**Existing**	**Ultimate**	**Existing**	**Ultimate**	**Existing**	**Ultimate**
Horizontal Surface:								
Horizontal Surface Elevation (feet)	496							
Horizontal Surface Radius (feet)	10,000	Same	10,000	Same	10,000	Same	5,000	Same
Conical Surface:								
Conical Surface Elevation (feet)	696							
Horizontal Distance (feet)	4,000	Same	4,000	Same	4,000	Same	4,000	Same
Slope	20:1	Same	20:1	Same	20:1	Same	20:1	Same
Primary Surface:								
Length beyond runway end (feet)	200	Same	200	Same	200	Same	200	Same
Width (feet)	1,000 [1]	Same	1,000 [1]	Same	500 [1]	Same	500 [1]	Same
Approach Surface:								
Inner Edge Width (feet)	1,000	Same	1,000	Same	500	Same	500	Same
Outer Edge Width (feet)	3,500	Same	16,000	Same	3,500	Same	1,500	Same
Horizontal Distance (feet)	10,000	Same	10,000 and 40,000 [2]	Same	10,000	Same	5,000	Same
Slope	20:1	Same [3]	34:1 [2]	Same	20:1	34:1	20:1	Same
Transitional Surfaces:	7:1	Same	7:1	Same	7:1	Same	7:1	Same

Source: *FAR Part 77, Objects Affecting Navigable Airspace*

Notes:

1. The width of the primary surface of a runway is the width prescribed for the most precise approach for either end of that runway; therefore, the precision approach to Runway 35 determines the primary surface width of 1,000 feet for Runway 17. Likewise, the non-precision approach to Runway 12 determines the primary surface width of 500 feet for Runway 30.
2. Federal Aviation Regulation Part 77's approach surface standards require a horizontal distance of 10,000 feet at a slope of 50 feet (horizontally) to 1-foot (vertically) with an additional 40,000 feet at a slope of 40 feet (horizontally) to 1-foot (vertically) for all precision instrument runways, such as Runway 35, a precision instrument approach runway. However, many airports within New England cannot meet the 50:1 slope requirements due to the mountainous terrain. Therefore, a slope of 34:1 is acceptable but the airport should strive to meet the 50:1 requirement if reasonably possible. An FAA modification to standards from 50:1 should be obtained.
3. According to discussions with SEA Consultants, Inc.,[iii] the engineering firm that designed Regional Drive, the roadway design was based on the clearances necessary for a 20:1 approach slope, which was listed as the existing and future slope on the 2001 approved and signed airport layout plan (ALP). However, the runway is a non-utility runway with a non-precision instrument approach, which requires a 34:1 approach slope. Due to the location of Regional Drive, the airport cannot meet the 34:1 standard.

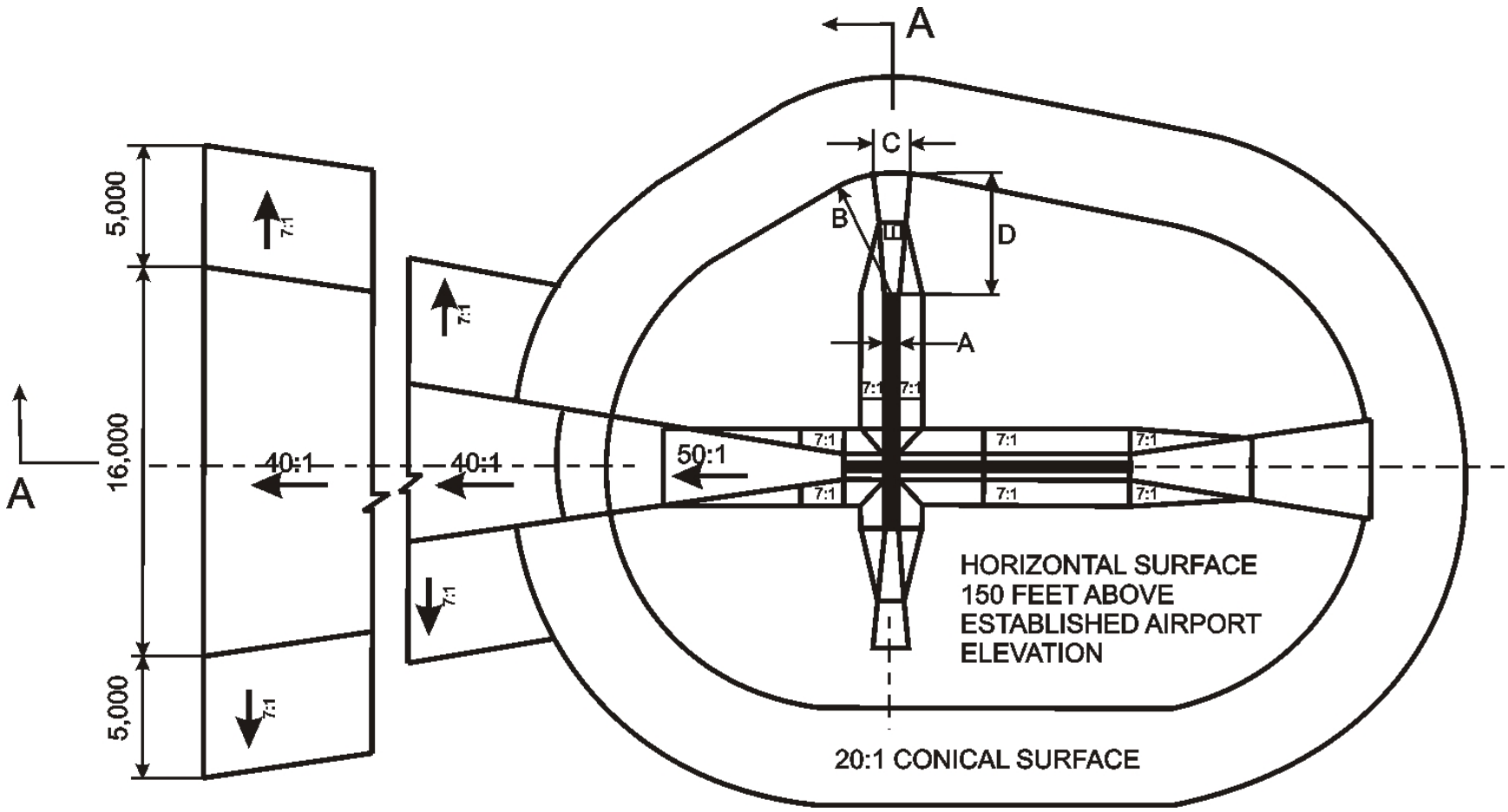

Figure 3-1: 2-Dimensional Graphical Depiction of FAR Part 77's Imaginary Surfaces

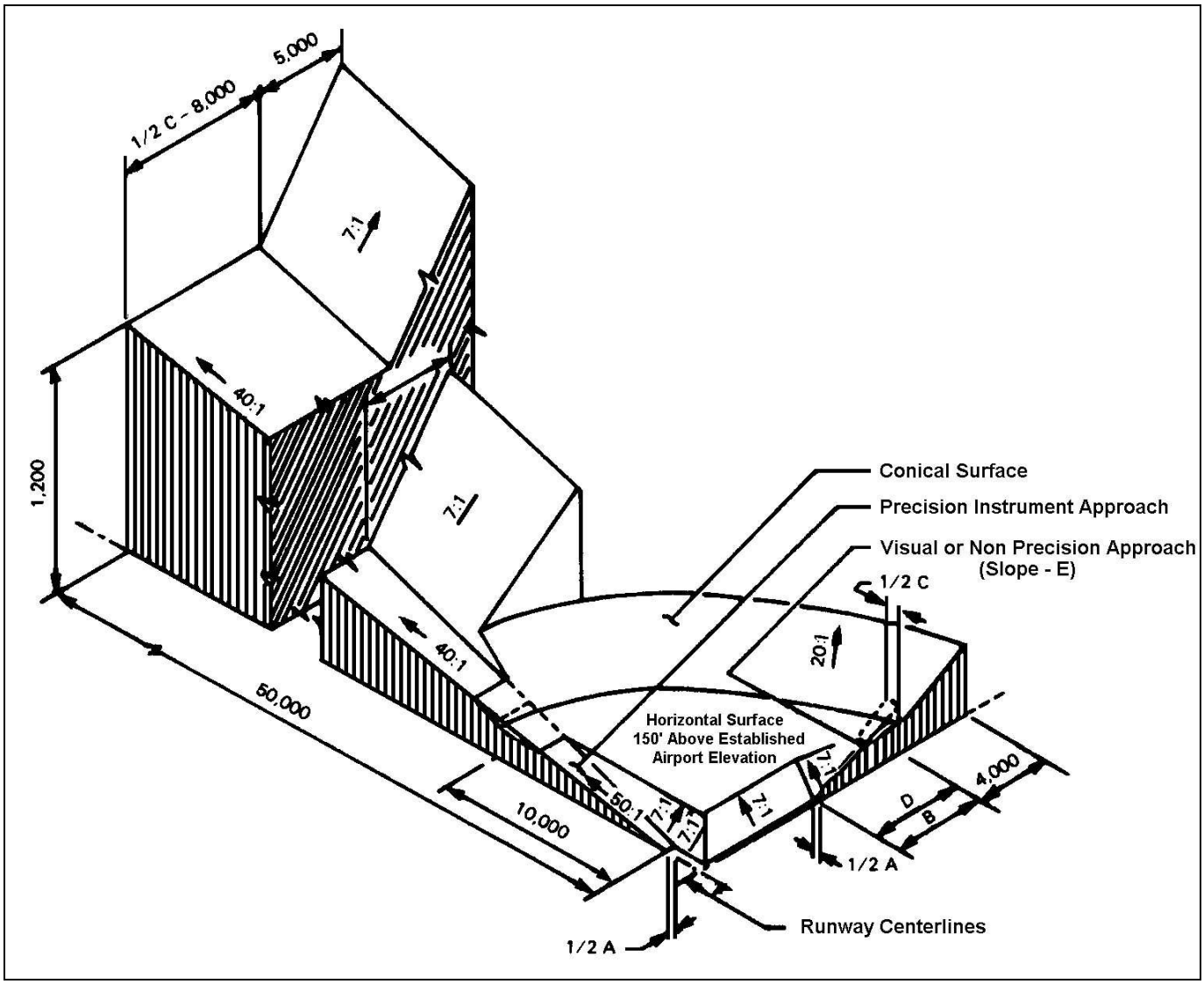

Figure 3-2: 3-Dimensional Graphical Depiction of FAR Part 77's Imaginary Surfaces

***Section 4.4 – Airside Obstructions/Imaginary Surfaces*, of this chapter, recommends improvements to protect navigable airspace from existing objects/obstructions.**

2.4 Protected Surfaces – Runway Visibility Zone

Line of sight standards are developed to allow clear visibility for individual runways from one end of the runway to the other, or for intersecting runways (similar to Concord Municipal Airport), from one end of an intersecting runway to another.[iv]

The FAA recommends that terrain within the visibility zone of the intersecting runways be graded and buildings sited in such a way so as to allow for unobstructed visibility from one runway end to the other.

***Section 4.4 – Airside Obstructions/Imaginary Surfaces*, of this chapter, recommends improvements to protect navigable airspace from existing objects/obstructions.**

2.5 Development Considerations – Existing Terrain

The Concord Municipal Airport is located on a plateau (known as the Concord Heights), which sits approximately 75 – 100 feet above the Merrimack and Soucook Rivers and their tributaries. Dense tree growth and significant terrain issues exist on the northeast and east sides of the airport. The terrain in this area drops steeply to the banks of the Merrimack and Soucook Rivers at a negative grade of 14 percent or more.

2.6 Development Considerations – Environmentally Sensitive Areas

As indicated in *Chapter 1 – Inventory*, a Conservation Management Agreement (see *Chapter 4 – Environmental Review* for further information) has been created for the purpose of managing airport lands that provide and enhance essential habitat for the Karner Blue Butterfly, a federally and State listed endangered species.

To protect the Karner Blue Butterfly and other State listed endangered and threatened species and their habitat, conservation areas, or zones, have been created on the airport. The airport is restricted from developing within the designated conservation zones.

For reference, the conservation zones (CZs) and development zones (DZs) are identified in *Chapter 5 – Airport Plans*, of this airport master plan update report.

2.7 Development Considerations Summary

Although the airport exists on 614-acres, land available for future airport development is limited due to the aforementioned protected surfaces, terrain issues and environmentally sensitive areas. Property acquisition for future airport development is also limited due to existing off-airport abutting properties that consist of major infrastructure, existing and/or planned industrial parks and commercial development, and residential dwellings.

Of the 614-acres of airport property, approximately 10 acres, less than 2 percent, is available for future airport development.

Facility improvements and future development recommendations within the remaining developable airport land are identified within the following sections.

3.0 Landside Facility Requirements and Alternative Development

The following sections assess the need for improvements to existing landside facilities and/or the need for additional facilities based on airport design criteria, known airport issues, and projected planning activity levels, while a graphic depiction of the proposed landside airport projects is shown in *Chapter 5 – Airport Plans*.

The following are evaluated:

- Aircraft Storage Facilities and Requirements (ramps and hangars)
  - Pavement Condition (ramps) and Rehabilitation Requirements
  - Based Aircraft Storage and Requirements
  - Itinerant Aircraft Storage and Requirements
- Automobile Storage Facilities and Requirements
- Terminal Building Facility and Requirements
- Aircraft Fueling Facilities and Requirements

Several alternative landside development options for the above facilities were presented at both the second and third airport master plan update workshop meetings held on February 3, 2005 and April 21, 2005. The preferred development options chosen within the following sections are the result of recommendations made by the consultant and discussions with the Planning Advisory Committee (PAC).

3.1 Aircraft Storage Facilities and Requirements

The following identifies the condition of the airport's aircraft storage facilities, the need for improvements to those facilities, and/or the need for additional facilities.

3.1.1 Pavement Condition (Ramps) and Rehabilitation Requirements

The typical life of pavement is 15 to 20 years. Of the three ramps at the airport, two are controlled, operated and maintained by the City (the based aircraft storage ramp and the itinerant aircraft storage ramp). The based aircraft storage ramp (south ramp) was constructed and the itinerant aircraft storage ramp reconstructed in 1991.

Based on typical life estimates, both the based aircraft ramp and the itinerant aircraft ramp are due for rehabilitation in 2011, or during the mid-term phase of this planning period.

3.1.2 Based Aircraft Storage and Requirements

As projected in *Chapter 2 – Aviation Demand Forecasts*, the based aircraft fleet is expected to grow from 92-based aircraft in 2004 to 137 in 2023, adding 45 based aircraft.

Table 3-4 identifies the based aircraft storage demand for both hangars and aircraft tie-downs at Concord Municipal Airport.

Table 3-4: Projected Based Aircraft Storage Demand

Year	2004 [1]		2008		2013		2023	
Equipment Type	Based Aircraft	Aircraft Storage Space Requirements @ 300 S.Y. per Aircraft [2]	Based Aircraft	Aircraft Storage Space Requirements @ 300 S.Y. per Aircraft [2]	Based Aircraft	Aircraft Storage Space Requirements @ 300 S.Y. per Aircraft [2]	Based Aircraft	Aircraft Storage Space Requirements @ 300 S.Y. per Aircraft [2]
Single Engine (SE)	65	19,500	71	21,300	80	24,000	99	29,700
Multi-Engine (ME)	7	2,100	7	2,100	8	2,400	9	2,700
Turboprop (TP)	4	1,200	4	1,200	4	1,200	6	1,800
Turbo Jet (TJ)	1	910 [3]	1	910 [3]	2	1,820 [3]	3	2,730 [3]
Helicopter (HE)	2	600	2	600	2	600	3	900
Other: Ultralight (UL)	5	1,500	5	1,500	6	1,800	7	2,100
Other: Glider (GL)	0	0	0	0	0	0	0	0
Other: type not specified	0	0	0	0	0	0	0	0
Experimental (EXP)	0	0	0	0	0	0	0	0
Military	8	2,400	10	3,000	10	3,000	10	3,000
Totals	**92**	28,210	**100**	30,610	**112**	34,820	**137**	42,930
Total Civilian Storage Need	**84**	**25,810**	**90**	**27,610**	**102**	**31,820**	**127**	**39,930**
Total Military Storage Need	**8**	**2,400**	**10**	**3,000**	**10**	**3,000**	**10**	**3,000**
Existing Based Aircraft Ramp Storage Space (S.Y.) [4]		15,555		15,555		15,555		15,555
Existing Based Aircraft Hangar Storage Space (S.Y.) [4]		6,833		6,833		6,833		6,833
Total Existing Based Aircraft Storage Space - Civilian (S.Y.) [4]		22,388		22,388		22,388		22,388
Total Surplus (Deficit) Based Aircraft Storage Space - Civilian (S.Y.) [4]		**(3,422)**		**(5,222)**		**(9,432)**		**(17,542)**
Surplus (Deficit) Storage Space for Small Single Engine/Light Multi-engine aircraft (S.Y.) [4]	**(8)**	**(2,512)**	**(14)**	**(4,312)**	**(25)**	**(7,612)**	**(49)**	**(14,812)**
Surplus (Deficit) Storage Space for Jet Aircraft (S.Y.) [4]	**(1)**	**(910)**	**(1)**	**(910)**	**(2)**	**(1,820)**	**(3)**	**(2,730)**

Notes:

1. Existing as of July 2004
2. According to the FAA in *AC 150/5300-13, Airport Design*, allowing 300 square yards is typical for based aircraft parking requirements for small single engine and light multi-engine aircraft[v]
3. As indicated in note 2, the 300 square yards per based aircraft rule is typical for small single engine and light multi-engine aircraft; however, this rule of thumb is too small for jet aircraft. Therefore, the square footage used is based on the critical aircraft, the Cessna Citation II, which requires approximately 910 square yards for aircraft parking per jet aircraft. This figure allows for the appropriate wingtip clearance needed for this aircraft.
4. Does not include the military based aircraft, only the civilian. The New Hampshire Army National Guard provides storage space for their aircraft/helicopters within their own facility and do not use the ramp space provided to the general public. They are responsible for the development of their own facilities and their based aircraft numbers are not used to justify additional aircraft storage space needed for the airport. Their numbers are only mentioned here to be consistent with previous chapters and provide the reader with a true indication of based aircraft needs.

As indicated in the table above, additional based aircraft storage space is required to meet both existing and projected demand.

To meet that demand, several alternative development options for based aircraft storage were created and provided to the PAC for review (see **Appendix A** located at the end of this report for based aircraft alternatives). **The PAC identified development zones 1, 3, 4 and 6 (see *Chapter 5 – Airport Plans* for locations) as the preferred areas for future aircraft storage development. The preferred alternative depicts development in areas that avoid impacts to conservation land.**

Discussions with airport tenants as well as visual inspection indicate a need to replace hangars 1, 2 and 3, which are some of the oldest aircraft storage hangars.[vi] The *March 1996 Concord Municipal Airport Master Plan Update*[vii] also recommended the rehabilitation and/or replacement of hangars 1, and 2. Further deterioration has occurred since the previous master plan, necessitating the replacement of all three hangars. **Therefore, it is recommended that the three aging hangars be replaced. Discussions with Concord Aviation Services, the airport's FBO, and the City identified phasing the replacement of the hangars as the preferred alternative. This method allows the City to continue to generate revenue from two hangars, while the remaining is undergoing replacement.** Current tenants have requested that the airport's water lines be extended to the new hangars in order to wash their hands and other sanitary purposes.

Typically there is more of a demand for hangars than based aircraft tie-down storage space, as aircraft owners prefer to have their aircraft under cover rather than exposed to the weather.

The actual mix between hangars and tie-down development should be based on the market demand, i.e. responding to an actual development proposal.

3.1.3 Itinerant Aircraft Storage and Requirements

There are currently 29 available itinerant aircraft storage spaces (two large) on the terminal ramp. However, that number fluctuates depending on the size of itinerant aircraft using the facility.

Chapter 2 – Aviation Demand Forecasts, projects that itinerant aircraft operations will remain at approximately 60 percent of the total number of annual operations throughout the planning period; currently approximately 34,400 (rounded to the nearest 100) of the total annual operations of 57,300. This equals approximately 94 itinerant aircraft operations per day. The number of total operations projected for 2023 is 85,400. This equals approximately 51,200 itinerant aircraft operations annually and 140 per day. It is poor planning, however, to assume that all existing 94 and future 140 itinerant aircraft would require aircraft storage space at the same time. Therefore, the peak hour itinerant operations outlined in *Chapter 2 – Aviation Demand Forecasts*, are used to determine future itinerant aircraft facility requirements.

Table 3-5 identifies the projected itinerant aircraft storage demand at Concord Municipal Airport.

Table 3-5: Projected Itinerant Aircraft Storage Demand

Year	Existing 2004	2008	2013	2023
Total Peak Hour Itinerant Operations [1]	23	25	28	34
Aircraft Storage Space Requirements @ 910 S.Y. per Aircraft [2]	20,930	22,750	25,480	30,940
Total Existing Itinerant Ramp Storage (S.Y.)	8,333	8,333	8,333	8,333
Surplus (Deficit) S.Y. (rounded to the nearest 100)	**(14 aircraft) or (12,600 SY)**	**(16 aircraft) or (14,400 SY)**	**(19 aircraft) or (17,200 SY)**	**(25 aircraft) or (22,600 SY)**

Notes:

1. Data collected from *Chapter 2 – Aviation Demand Forecasts, Table 2-9: Projected Local and Itinerant Operations (Rounded to the Nearest 100)*
2. According to the FAA in *AC 150/5300-13, Airport Design*, allowing 360 square yards is typical for itinerant aircraft parking requirements; [viii] however, 360 square yards does not provide adequate spacing for the larger multi-engine and jet aircraft that typically make up the mix of itinerant aircraft using the airport as indicated in *Chapter 1 – Inventory, Table 1-7: Aviation Related Companies that Typically Operate at Concord Municipal Airport.* Since it is best to use the upper levels of a range when forecasting to insure adequate space will be set aside, the square footage used is based on the wingtip clearance requirements for the critical aircraft, the Cessna Citation II, which requires approximately 910 square yards for aircraft parking.

As indicated in the table above, additional itinerant aircraft storage space is required to meet both existing and future demand. In addition to the projected demand, Roush Racing also requires storage space for two-Boeing 727's that operate at the airport during the National Association for Stock Car Auto Racing events (NASCAR races) held at the New Hampshire International Speedway on select weekends in July and September. The aircraft are also used occasionally at other times during the year conducting charter flights.[ix] Typically, the two aircraft are parked on the closed runway (Runway 03-21) during race events.

To meet itinerant aircraft storage demands, several alternative development options were created and provided to the PAC for review (see **Appendix B** located at the end of this report for itinerant aircraft alternatives). **The PAC identified the preferred alternative to be continued use of the existing terminal ramp and the closed runway when necessary for overflow itinerant aircraft storage during busy race weekends. They also identified the need to construct a concrete ramp to accommodate larger and heavier jet aircraft such as the Boeing 727's used by Roush Racing. The area chosen for the concrete ramp is located north of the terminal building (see *Chapter 5 – Airport Plans* for location).**

The advantages of constructing a concrete ramp are:[x]

1. The ability to carry aircraft loads heavier than the design load;
2. Concrete paving resists degradation by fuel spillage, oil drippings, jet heat and blast;
3. Concrete paving resists rutting under parked aircraft;
4. Concrete paving does not require the periodic resurfacing or surface sealing required by asphalt paving;
5. Concrete paving has a longer life expectancy than asphalt paving; and
6. Provides a suitable area for larger and heavier jet aircraft, reducing the need for those aircraft to park on existing failing and/or unsuitable pavement

It is also recommended that the airport implement all necessary safeguards, especially during busy periods when overflow itinerant aircraft storage is required on the closed runway, to help ensure avoidance of any pedestrian/aircraft incident.

3.1.4 Aircraft Storage Facilities and Requirements Summary

The development necessary to accommodate future aircraft storage identifies the use of the existing development zones and the closed runway for overflow aircraft storage during special events and busy NASCAR race weekends. Review of aircraft storage facility projections indicates both an existing and future deficit. Analysis of land available at the airport for such development also indicates a future deficit. This land deficit is projected to take place in the long-term future (i.e. within the next 10 to 20 years). Discussions with the United States Fish and Wildlife Service and the New Hampshire Fish and Game Department in March 2005 to address the land deficit (see **Appendix C** for overview of meeting) led to the possibility of adjusting the boundaries between conservation zones and development zones in a way that creates more aircraft storage areas while maintaining or improving essential habitat for the Karner Blue Butterfly.

Ideally, aircraft storage facilities are constructed in close proximity to existing facilities such as fuel facilities, the terminal building, restrooms and other amenities. Currently, a majority of the land surrounding the existing based and itinerant aircraft storage facilities is conservation land, thus limiting future expansion of the existing aircraft storage facilities. Conservation zone 4, located between the existing parallel taxiway and Airport Road, would be the ideal place for future aircraft storage development. Thus, we discussed the possibility of re-designating development zone 8 to a conservation zone and conservation zone 4 to a development zone.

Representatives of the United States Fish and Wildlife Service[xi] and the New Hampshire Fish and Game Department[xii] indicate that an inventory of both development zone 8 and conservation zone 4 is required before a determination can be made regarding a zone re-designation. As of June 2005, a determination regarding re-designation had not been made. However, it is recommended that the City of Concord pursue re-designation possibilities with both agencies in the future.

3.2 Automobile Storage Facilities and Requirements

Concord Municipal Airport has ten paved automobile parking lots with 287 parking stalls, 89 of which are available to the general public. All others are privately owned and used by airport tenants under existing airport lease agreements.

As identified in *Chapter 1 – Inventory* of this report, the airport is in need of additional **public** automobile parking during busy NASCAR race weekends. During NASCAR race weekends at least 200 additional rental automobiles are trucked in by Hertz and Enterprise-Rent-A-Car to accommodate increases in demand. Also, at least 500 plus fans congregate at the airport during race weekends to catch a glimpse of the drivers and race teams.

To handle the increases in demand, the airport utilizes grass areas located inside and outside of the airport security fence for additional automobile parking. However, parking inside of the secure airport is a safety concern due to the potential for runway incursions (because of the mix of aircraft and automobiles) and a safety problem the airport desires to remedy with additional parking outside of the secure airport area.

Several development options to meet peak automobile storage demand were created and provided to the PAC for review (see **Appendix D** located at the end of this report for automobile storage alternatives). **The PAC agreed that the existing parking lot should be expanded to the southeast, closer to hangar #3, and that two access points, one located off of Regional Drive and one located off of Airport Road, should be created. They also identified the development of a turf parking lot for overflow automobile rental and fan parking located northwest of Regional Drive (see *Chapter 5 – Airport Plans* for location).** The FAA indicated that they would allow for automobile parking beneath the runway protection zone for Runway 12 during peak activity.[xiii]

A turf parking lot is desired for the following reasons:

1. Overflow automobile parking is necessary only during special events and busy NASCAR race weekends (at most, 2 to 4 times per year). Year-round maintenance of a gravel and/or paved parking lot would be expensive and burdensome;
2. Maintaining a turf surface allows the City/airport some flexibility, enabling them to use that area for some other revenue producing use in the future; and
3. A turf surface would not increase the airport's impervious surfaces, providing a more environmentally desirable alternative

3.3 Terminal Building Facility and Requirements

Chapter 1 – Inventory identified the terminal building as an old structure (brick and wood frame structure built in 1938 and expanded in 1961), that is in poor condition with several significant code violations, structural deficiencies, inadequate security devices and inability to meet the 1990 Americans with Disabilities Act (ADA) regulations without major renovations. An updated and/or new facility is definitely required.

The City is proposing to either renovate the existing structure or construct a new facility that not only addresses the code violations but also addresses the need for a terminal facility that presents a modern, functional "front door" to the City.

The City asked that the master plan analyze the following:

- Re-evaluate the need for a new terminal building location;
- Provide access, if at all possible, to the terminal building from the Regional Drive extension; and
- Explore the possibility of combining a new terminal building with a new structural fire station (Concord Heights Fire Station) that would benefit both the neighborhood and the airport

3.3.1 Provision of a New Terminal Building Location

Advisory Circular (AC) 150/5360-9, Planning and Design of Airport Terminal Facilities at Nonhub Locations, identifies terminal location factors that should be considered when analyzing terminal building site locations.[xiv] Although the advisory circular is geared towards nonhub airports with air carrier activity, rather than general aviation airports, such as Concord Municipal Airport, the location factors identified within the AC are good tools to use to evaluate the terminal building site location options for Concord Municipal Airport.

The following four major terminal location factors are identified within the AC:

1. Relationship of the terminal building to the airfield;
2. Relationship of the terminal building to other airport facilities;
3. Physical siting considerations; and
4. Relationship of the terminal building to roadways

The *March 1996 Concord Municipal Airport Master Plan Update*[xv] used these terminal location factors to analyze terminal building renovation and relocation options. It was determined in that plan that although the building is in need of significant rehabilitation, the location of the existing building, …"is well located in relation to the major aviation components of the airport (i.e., ramp, tie-downs, fuel farm, hangar space, etcetera)."[xvi]

Prior to coming to that conclusion, the March 1996 master plan identified the following three alternatives in regards to the terminal building location/modification:

1. Option 1A – Rehabilitate the existing building
2. Option 1B – Construct a new building in the same general location
3. Option 1C – Construct a new terminal in a new location

Option 1A, rehabilitate the existing building, was chosen as the preferred option in the March 1996 master plan because it was the least-cost option, remained in close proximity to major aviation components and because the space needs for the airport could be met within the footprint of the ground floor. Option 1B, although a good option, was more costly and was not chosen. And Option 1C was considered far too removed from existing aviation components and infrastructure and would include the added expense of extending Regional Drive and utilities and thus was not considered a viable location.

Review of the three options provided in the March 1996 master plan also identified the existing terminal building location to be the best location to either renovate or to build a new facility. Although utilities were extended in 2001 to the area identified as Option 1C (due to the construction of the snow removal equipment building) and as of December 2004, the Regional Drive extension was opened for

automobile traffic, the location (Option 1C) was not chosen within this master plan for the following reasons:

1. The remote area is considered far too removed from existing aviation components and infrastructure (i.e., fixed based operator, ramp, tie-downs, fuel farm, etcetera);
2. The needs of the itinerant traveler are better met at the existing terminal location due to the existing aforementioned aviation components; and
3. As of the 2001 signed airport layout plan, the location identified as Option 1C has been identified as the best location for future based aircraft storage development. In fact, plans for the development of additional hangars is anticipated to take place in the summer/fall of 2005

Due to these considerations, maintaining the terminal building in the same general location is recommended. Two possible approaches exist for the development of the terminal facility: 1) the renovation of the existing terminal building, or 2) the construction of an entirely new terminal facility in the same general location. An evaluation of the merits and challenges associated with each approach has been performed, **and the construction of a new terminal building is the recommended approach**. A review of the factors leading to this recommendation is included below.

3.3.2 Renovation Approach

Consideration of the renovation option begins with a visual assessment of the facility's condition, and known building code requirements. Overall the facility's structure is viewed to be in poor condition. Significant upgrades to, and in many cases outright replacement of the facility's systems and construction would be required, as well as alterations to comply with current ADA accessibility requirements. If considered as part of a renovation project, the amount of alteration/renovation required is significant enough to characterize the project as a 'gut' renovation, rather than selective alteration. The budget required for this approach would reflect the significant level of renovation, which would likely be required.

Summary of Perceived Advantages of the Renovation Approach

1. Potentially less costly than build new; and
2. The building can remain open (phased construction) while renovations take place in different areas of the building.

Summary of Perceived Limitations of the Renovation Approach

1. The phased approach could take longer i.e. longer overall construction schedule, which may mean greater contractor overhead and general conditions costs;
2. Additional costs may be associated with a temporary construction (dust and debris control, safety partitions, temporary structures to maintain terminal operations and security during construction); and
3. The airport would need to perform multiple 'moves' to conduct terminal operations in some areas while allowing for construction to proceed in others.

3.3.3 Build New Approach

The primary limitation on building a new facility is the need to demolish the existing building to allow for new building development.

Summary of Perceived Advantages of the Build New Approach

1. An entirely new facility can be constructed without phased construction. This approach avoids costs associated with temporary construction, phased construction, and a longer overall construction schedule; and
2. The build-new approach would result in a coherent unified facility providing the best aesthetic and functional experience for both passengers/visitors and airport tenants. Under the renovation approach, some compromises and functional/aesthetic difficulties would inevitably remain.

3.3.4 Order-of-Magnitude Cost Estimate

When analyzing terminal building size requirements peak hour passenger levels are used. A rule of thumb factor commonly used is an average of 3 passengers {pilot and passengers} per itinerant aircraft operation and 1.5 passengers {pilot and passengers} per local aircraft operation.[xvii] Using the rule of thumb method and data from the previous master plan report the following space requirements are calculated for a terminal building at Concord Municipal Airport:[xviii]

1. Lobby/public waiting area		± 1,900 square feet
2. Departure area/lounge/miscellaneous		± 500 square feet
a. Telephones		
b. Concession machines		
c. Restrooms		
3. Tenant/office area		
a. Car rental company		± 100 square feet
b. Other tenant/office areas		± 2,000 square feet
c. Leased area (i.e. a restaurant)		± 1,500 square feet
4. Airport management		± 250 square feet
a. Conference room		± 400 square feet
	Subtotal:	**6,650 square feet**
5. Building mechanical systems (15 percent of gross terminal area)		± 1,000 square feet
6. Circulation space (20 percent of gross terminal area)		± 1,330 square feet
	Total:	**8,980 square feet**

This calculated space requirement equals roughly the same size of the existing building, a 9,000 square-foot building. The cost factors (based on 2004 construction dollars) for a 9,000 square foot building are as follows:

Renovation:	$150.00 - $200.00 per square foot
New Construction:	$200.00 - $250.00 per square foot

The actual per square foot cost will vary within the above range based upon actual selection of finish materials, design complexity, and market conditions. For the purposes of this analysis, a midrange cost of $175.00 per square foot for renovation and $225.00 per square foot for new construction is being carried. **Note that these costs represent building construction costs only**, and are independent from site/civil, landscaping, furniture and equipment, and soft costs which would normally be associated with a project of this type. A summary of the anticipated construction cost for the various approaches is outlined in **Table 3-6**.

Table 3-6: Anticipated Terminal Building Construction Cost – Renovation Versus Build New

Renovation Approach			Build New Approach		
Building Size (Square Foot)	**Cost Estimate per Square Foot**	**Building Cost Estimate**	**Building Size (Square Foot)**	**Cost Estimate per Square Foot**	**Building Cost Estimate**
9,000	$175	$1,575,000	9,000	$225	$2,025,000

Note 1: Above budgets represent preliminary terminal construction costs only, in 2004 dollars. Amounts do not include construction contingency allowances, 'soft costs' such as designer fees, testing, owner-related administrative costs, furniture and equipment, or technology.

Note 2: The 'Build New' approach is likely to involve site/civil engineering and construction costs which are not included above, and which would likely not be required to the same degree as part of the Renovation Approach.

Note 3: The purpose of this comparison is to illustrate the potential cost differences between the Renovation and Build New approaches, and not necessarily to set a project budget for one or the other. Upon selection of a project approach, likely schedule, and definition of related civil work, a more accurate anticipated project budget can be developed.

3.3.5 Terminal Building (New Versus Renovate) - Recommendations and Conclusions

Although renovation of the existing facility is definitely a potential option, the efficiencies associated with the construction of a new facility, the potential for constructing a smaller facility because of a more effective floor plan and the relatively small cost difference between the two approaches, result in the recommendation to build a new terminal facility in the location of the existing facility. This approach provides the most long-term benefits and flexibility while avoiding the challenges associated with renovation of the existing facility.

The provision of access to the terminal building from the Regional Drive extension is covered in *Section 3.2 - Automobile Storage Facilities and Requirements*, in which the preferred alternative would create two access points, one off of Regional Drive and one off of Airport Road.

3.3.6 Exploration of Combining New Terminal Building With Concord Heights Fire Station

Discussions with staff at the Concord Heights Fire Station[xix] indicate that a fire station site location study is planned to start this year (summer 2005). The study is intended to determine the best location for the City's fire station facilities based on call volumes and population within the City of Concord. They also indicate that if the airport were chosen as the best location for their new facility, the most desirable locations would be a joint terminal/fire station facility in the location of the existing terminal building or along Regional Drive, west of the new New Hampshire Army National Guard facility.

The size of the fire station facility needed is approximately 8,200 square feet (3,900 of which is strictly for fire vehicles, while the remainder is for living, exercising, working and dining space).[xx]

Many fire stations desire an equipment storage bay with operating front and back doors and a circular driveway that allows the fire vehicles to be driven into the bays, avoiding the need to back the vehicles into the bays for storage. The Concord Heights Fire Station staff member indicates that they do not need to have such a design. However, they did indicate instead that they would like to have one door open to the airfield if they have a dedicated airport fire vehicle and the rest of the doors to open to the public roadway.

It is recommended that the fire station facility and the terminal building facility be constructed separately due to the following:

- The airport is in dire need of ramp and automobile space. The best place for the terminal building is where it is located. Development of a fire station on property that is prime real estate for aircraft storage space and aviation related businesses/uses is not a good use of airport land when other property locations and options within the City are available for the fire station; and
- The fire vehicles would require access directly onto a public roadway, possibly eliminating the potential for additional automobile parking in front of the terminal building, an undesirable option since additional parking at the airport is in great demand.

Those present at the February 3, 2005 meeting agreed with this recommendation as the preferred alternative.

3.4 Aircraft Fueling Facilities and Requirements

In *Chapter 1 – Inventory*, Concord Aviation Services, an airport operator, expressed a need for **an additional 18,000-gallon Jet-A fuel storage tank** to accommodate the increased fuel demand during special events. The additional tank should be installed and hooked up in parallel to the existing tank thus allowing for the use of the existing pumping and filtering equipment.

An airport safety and compliance inspection completed by the FAA on July 21, 2004 (**Appendix E** provides copy of the inspection letter) indicated that aircraft fueling trucks were not within FAA specified guidelines. For purposes of safety and separation, the FAA recommends that aircraft fueling trucks be parked a minimum of 10 feet apart and no closer than 50 feet from buildings.

It is recommended that the additional tank be installed in the earlier stages of this planning period or during rehabilitation of the based or itinerant aircraft ramp. Installation during pavement rehabilitation may reduce some of the cost associated with the project.

4.0 Airside Facility Requirements and Alternative Development

The following sections assess the need for improvements to existing airside facilities and/or the need for additional facilities based on airport design criteria, known airport issues, and projected planning activity levels, while a graphic depiction of the proposed airside airport projects is shown in *Chapter 5 – Airport Plans.*

The following facilities are examined:

- Runways
- Taxiways
- Visual and Navigational Aids
    - Marking, Lighting, Signs and Navaids
- Airside Obstructions/Imaginary Surfaces

Several alternative airside development options for the above facilities were presented at both the second and third airport master plan update workshop meetings held on February 3, 2005 and April 21, 2005. The preferred development options chosen within the following sections are the result of recommendations made by the consultant and discussions with the PAC.

4.1 Runways

The following identifies the condition of Runways 17-35 and 12-30 and identifies facility improvements where necessary.

4.1.1 Runway Pavement Condition

As indicated in *Chapter 1 – Inventory*, Runway 17-35 was reconstructed in 1990 and narrowed from 150 feet to 100 feet, by changing the paint marking to indicate a 100-foot runway. The 50-feet of pavement still remains and turned into 25-foot paved runway shoulders located on either side of the runway. For the most part, the runway pavement is in very good condition. However, the shoulders are in fair condition with vegetation growth, cracking and loose pieces of asphalt.

Runway 12-30's pavement is in excellent condition. The reconstruction and narrowing of Runway 12-30 from 100 feet to 75 feet was completed in 2002.

The life expectancy of pavement is 15 to 20 years. Runway 17-35 will reach the end of its designed pavement life within the next five years, in 2010, or during the short-term phase of this planning period. Runway 12-30 will require rehabilitation prior to 2022, or during the long-term phase of this planning period. **Due to the data provided above, it is recommended that both runways be scheduled for rehabilitation within this planning period. It is also recommended that the two 25-foot runway shoulders for Runway 17-35 be removed and converted to turf for the following reasons:**

1. Removal of shoulders will eliminate the potentially hazardous condition of loose pieces of asphalt and rock that could appear on the runway surface and be ingested into an aircraft engine;
2. Elimination of the shoulders will reduce the amount of pavement requiring maintenance; and
3. Removal of the shoulders will decrease the amount of impervious surface on the airport, providing an environmental improvement

4.1.2 Airport Design Criteria and Condition

As indicated in *Section 2.1 - Protected Surfaces - Airport Design Criteria*, of this chapter, the preferred airport design criteria is B-II for both Runways 17-35 and 12-30. The dimensional design requirements for a B-II airport are outlined in Table 3-2 of Section 2.1.

The following defines the design criteria that must be met, identifies the existing conditions for each design element and makes recommendations for improvement for those items not meeting criteria.

Runway Protection Zones (RPZ)
Within *Section 2.1 - Protected Surfaces - Airport Design Criteria*, of this chapter, the basic design criteria for runway protection zones is provided identifying items that are either permissible or prohibited from within the RPZ. The following identifies the condition of the RPZ for each runway and makes recommendations for improvement.

Runway 12 - Approximately half of the existing RPZ for Runway 12 is located within airport property boundaries. The other half (approximately 7 acres) extends over land not owned by the airport, existing over buildings for public assembly (the old New Hampshire Army National Guard facility) and public roadways, Regional Drive.

Runway 30 - The entire RPZ for Runway 30 is located within airport property situated over conservation land.

Runway 17 - Approximately 6 acres, or 44 percent of the existing RPZ extends into lands that are not owned by the airport and lies over residential buildings/property.

Runway 35 – A majority of the RPZ for Runway 35 is located within airport property boundaries. A small portion lies over residentially owned property.

The *March 1996 Concord Municipal Airport Master Plan Update* identified the need to either purchase avigation easements or land that is not owned by the airport to protect the RPZ for each runway. As of this master plan update, easements have been acquired for the properties located within the existing RPZ for Runway 35. Also, some properties, which are located within the existing RPZ for Runway 17 have been purchased by the City: a 0.71 acre parcel, a 4.66 acre parcel and a 1.32 acre parcel.

The City is aware of the need to purchase additional avigation easements and/or properties due to recommendations made in the March 1996 master plan update. Such purchases are currently included in their five-year airport Capital improvement Plan (CIP). **This master plan recommends that the airport continue to plan for the purchase of easements and/or properties in an effort to protect the RPZ that extends into lands that are not owned by the airport and to allow the airport to control the height of objects within the RPZ for Runways 12 and 17. Future plans to extend Runway 35 (see *Section 4.1.4 – Runway Issues* of this chapter) may require the acquisition of additional easements and/or property in the future.**

Runway Width

As indicated in Table 3-2, the required runway width is 75 feet. Both runways meet or exceed the existing runway width criteria. Runway 17-35 is 100 feet in width, while Runway 12-30 is 75 feet. Although Runway 17-35 is 25 feet wider than required, width reduction is **not** recommended due to the following:

- The additional width should be maintained to provide a buffer/safety zone during crosswind landings; and
- As established earlier, the majority of aircraft using the airport fall into the B-II design criteria requiring a 75-foot runway. However, operations by larger aircraft typically requiring a 100-foot wide runway exist. Therefore, to better accommodate those larger jet aircraft that frequent the airport, the 100-foot width should be maintained

Due to the above reasoning, runway width reductions and/or increases in runway width are not warranted and, thus, are not recommended within this planning period for Concord Municipal Airport.

Runway Shoulders, Blast Pads, Safety Areas, Object Free Areas and Obstacle Free Zones

The following defines design standards for runway shoulders, blast pads, safety areas, object free areas and obstacle free zones and makes recommendations for improvement for those items not meeting criteria.

Runway shoulders and blast pads are designed to provide resistance to blast erosion.[xxi] They are typically designed as turf (grass) areas allowing for good coverage of the surrounding soil to reduce the possibility of soil erosion. If the soil is unprotected adjacent to runways and taxiways it typically is susceptible to erosion.

The runway safety area (RSA) is a graded, rectangular area, centered on the runway centerline, and extended beyond the runway ends and runway edges. The RSA must be cleared, appropriately graded and drained. It must be free of objects, except those that need to be there due to their function, such as navigational aids. It should be capable of supporting airport mobile equipment, rescue equipment, and

the occasional passage of aircraft under dry conditions. Any object located within the RSA higher than three inches must be constructed with frangible supports, with the frangible point no higher than three inches above grade. The maximum permissible longitudinal grade requirement for the first 200 feet of the RSA, beyond the runway ends, is between 0 and 3 percent sloping downward from the runway ends. The maximum permissible longitudinal grade for the remainder of the safety area is a negative grade of 5 percent. The negative grade is to ensure that no part of the RSA penetrates the approach surface for that runway.

The **runway object free area (OFA)** requires clearing of above ground objects protruding above the RSA edge elevation, except for navigational aids as mentioned above.

The **runway obstacle free zone (OFZ)** is defined as a volume of airspace centered above the runway centerline. This area prohibits taxiing and parked aircraft. It is to remain free of obstacles and object penetrations, except for objects that need to be located there because of their function, such as navigational aids.

The design standards for the above elements are currently not being met due to the following:

- The soil surrounding each runway does not have good coverage due to the clumping of grass caused by the lack of mowing and has caused erosion. Although this is the case for both runways, the eroding soil on the north side of Runway 12-30 (at the intersection of the closed runway) has allowed for a runway edge lip to be greater than the maximum three inches above grade. Likewise, the eroding soil on the south side of Runway 12-30 (east of the intersection of the closed runway) has allowed for the same runway edge lip to be greater than the maximum three inches above grade.[xxii];
- Vegetation growth around existing drainage catch basins (Runway 17-35 and it's parallel taxiway) has allowed for poor drainage within the runway safety areas and safety zones;
- Obstacles such as small trees and brush, reaching heights greater than 3 feet are located within the following safety areas and safety zones for both runways:
    - Runway object free areas;
    - Runway obstacle free zones;
- Some navigational aids, such as signs and lighting, which are allowed within safety areas and safety zones, albeit, constructed with frangible supports, have the frangible point ***higher*** than the standard three inches above grade; and
- Some navigational aids, such as signs and lighting are obscured due to vegetation growth

The above discrepancies were noted during the airport inventory (July 2004) and an airport safety and compliance inspection completed by the FAA on July 21, 2004[xxiii] (see **Appendix E** for the compliance inspection letter).

In an effort to meet FAA regulations regarding the condition of the runway shoulders, blast pads, RSA, ROFA and ROFZ the following is recommended:

1. To reestablish a more appropriately graded and suitable surface surrounding both runways, it is recommended that the necessary fill, grading of the turf surfaces and re-seeding be accomplished in the areas identified with poor soil coverage and in those areas where the runway edge lips are greater than the maximum three inches above grade;
2. To meet FAA criteria regarding the height of the frangible point on several airfield sign bases and light bases, necessary fill, grading of the turf surfaces and re-seeding is necessary and recommended to establish the frangible point at the required maximum of three inches above grade;

3. Remove the small trees located within the ROFA/ROFZ and other penetrating brush/vegetation growing near the drainage catch basins; and
4. Allow for regular mowing and maintenance to avoid grass clumping and vegetation accumulating around the runway edges, signs, light bases and drainage catch basins.

Due to the existing Conservation Management Agreement and supplemental Habitat Management and Monitoring Plan, coordination with the New Hampshire Fish and Game Department and the United States Fish and Wildlife Department is necessary prior to any mowing and/or improvement to ensure that both the airport's safety goals and the habitat management goals are being reasonably met (see the airport's mowing schedule, **Appendix F**, which should be viewed as a frequently updated maintenance and mowing schedule).

Runway Separation Standards

All runways have separation standards that are determined by the airport's approach category and approach visibility minimums. Separation standards are developed for airports to provide a safe separation between different airport operations. Runway separation standards are determined from the runway centerline to a parallel runway, a holdline, a taxiway/taxilane centerline, an aircraft parking area, or a helicopter touchdown pad.

As indicated in the Table 3-2, both Runways 17-35 and 12-30 meet the minimum required runway separation standards. **Therefore, upgrades are not required and/or recommended within this planning period. However, it is recommended that all future development meet the required separation criteria.**

4.1.3 Runway Issues

At the onset of this study, it became clear that there are two primary runway issues that need to be addressed. They are as follows:

1. The confusing intersection at the approach ends of Runways 17 and 12; and
2. An extension to Runway 17-35

Intersection of Runways 17 and 12

Inspections by FAA personnel have cited the intersection of Runways 17 and 12 as confusing due to the following factors:

- The existing signage at the intersection of the approach ends of both Runways 17 and 12 does not provide adequate direction to either approach end;
- The taxiway and runway paint markings leading to the approach ends of both runways are dull and faded and need to be repainted;
- The grass is too high obscuring signage and lights; and
- The taxiway leading to the approach end of both runways is a large asphalt area that adds to the confusion due to the lack of marking, lighting and signage to direct you to the approach end of the runway.

Several development options to alleviate the confusion at the intersections were created and provided to the PAC for review (see **Appendix G** located at the end of this report for each alternative). The options presented included major reconfiguration of the area to rectify the situation. The **PAC members indicated that major reconfiguration of the area is unnecessary and identified the preferred development alternative to be better marking, signage, lighting and overall maintenance of the area to rectify the problem. It is also noted that the stub taxiway, Taxiway A1, should be realigned to provide more cohesion between the taxiway and both runway ends with the existing**

taxiway being used for aircraft engine run-up/preflight engine and aircraft systems monitoring prior to takeoff.

Runway Length – Purpose and Need

Appendix H of this report provides technical support identifying the need for additional runway length for Runway 17-35 at Concord Municipal Airport. The analysis indicates that the current runway length of 6,005 feet is capable of safely accommodating nearly every single-engine piston, multi-engine piston, and a majority of the twin turbo-prop general aviation aircraft. However, the 6,005-foot runway is deemed inadequate for a majority of the most commonly used business jet aircraft.

Industry trends indicate business jet aircraft use in the United States is on the rise. According to the FAA in the *FAA Aerospace Forecasts, Fiscal Years 2004 – 2015*,[xxiv] "…corporate/business flyers are turning more toward private/company jets to conduct domestic and international business in times of heightened security. Despite the slowdown in the demand for business jets, the current forecast assumes that business use of general aviation aircraft will expand at a more rapid pace than that for personal/sport use." More and more business travelers and corporations have also turned to business jet aircraft as alternatives to business travel. The onset of on-demand charter flights and fractional jet aircraft ownership provides corporations and individuals with the freedom, flexibility, convenience, and access to a jet aircraft to fly whenever and wherever they want in order to meet individual business or personal objectives. Such freedom of travel has spurred business travelers to fly into smaller hub and general aviation airports that are closer to their final destination than the typical large hub airports. Concord Municipal Airport happens to be one of many general aviation airports within the New England region that have witnessed a rise in business jet traffic. To accommodate the rise, the airport desires to provide business travelers and business jet aircraft users with adequate airport facilities, such as ramp storage space, fuel, a modern terminal facility, and additional runway length.

Improvements to the runway's overall length are needed to: 1) accommodate existing and future jet traffic operations; 2) improve safety; and 3) increase the economic viability of the airport. Existing business jet users are currently required to compensate for the shorter runway by operating at less than useful load (i.e. less fuel, passengers or cargo). A longer runway would allow existing business jet users to operate closer to 100 percent of their useful load. Such increases in length not only improve safety by providing adequate runway length for the most common business jet aircraft, but also increase the economic viability of the airport. A longer runway and increased operational capability translates into more fuel sold; increased taxes from fuel sales; and potentially additional rent and property taxes from the lease of aircraft and hangar storage space to aircraft owners that otherwise would not have used the airport.

The runway length analysis identified the types of aircraft the airport is capable of serving today and those it can serve in the future with additional runway length. The analysis documented runway length requirements for 48 of the most popular business jet aircraft used today. The following list provides the number of aircraft that various runway extensions would support.

Runway Length (feet)	Number of Business Jet Aircraft Supported
6,005 (current)	19 of 48 (39%)
6,505	36 of 48 (75%)
6,755	40 of 48 (83%)
7,000	43 of 48 (90%)
7,500	48 of 48 (100%)

Based on the calculations conducted for these specific aircraft, the current 6,005-foot runway at Concord Municipal Airport can only accommodate 19, or 39 percent, of the 48 most popular business jet aircraft without any weight restrictions. In an effort to accommodate the airport's existing and future jet traffic, additional runway length should be considered in future development plans for Concord Municipal Airport.

Runway Length – Alternative Development Options

It is apparent from the list above that the operational benefits increase with additional runway length. However, the question is, what runway length is justifiably reasonable for Concord Municipal Airport and at what level of impact? Some would infer that the alternative providing the best operational benefit, such as the 1,500-foot runway extension, would be the most appropriate alternative. However, the benefits and impacts associated with such an extension must first be analyzed and compared to other alternatives.

Four runway length alternatives are evaluated for Runway 17-35: a 500, 750, 1,000 and 1,500-foot runway extension. The operational benefits of each alternative are identified and summarized in **Table 3-7.** Potential impacts associated with each alternative are identified and summarized in **Table 3-8** with a graphic depiction of those impacts illustrated in **Figures 3-3** through **3-6.**

Additional runway length will be constructed on the Runway 35 approach end due to obstructions and other developmental constraints associated with the Runway 17 approach end.

Each alternative also ensures that the runway safety areas can be reasonably met.

Table 3-7: Concord Municipal Airport – Runway 17-35 Length Analysis – Operational Benefits

Alternatives	RSA Dimensions (feet)		Runway Pavement Length (feet)	Runway 17 Displaced Threshold Length (feet)	Operational Runway Length (feet) [1]					Most popular business jet aircraft accommodated [2] (percent)
	Length	Width			Runway	TORA	TODA	ASDA	LDA	
Existing	300	150	6,005	640	**Runway 17**	6,005	6,005	6,005	5,365	39
					Runway 35	6,005	6,005	6,005	6,005	
1	300	150	6,505	640	**Runway 17**	6,505	6,505	6,505	5,865	75
					Runway 35	6,505	6,505	6,505	6,505	
2	300	150	6,755	640	**Runway 17**	6,755	6,755	6,755	6,115	83
					Runway 35	6,755	6,755	6,755	6,755	
3	300	150	7,005	640	**Runway 17**	7,005	7,005	7,005	6,365	90
					Runway 35	7,005	7,005	7,005	7,005	
4	300	150	7,505	640	**Runway 17**	7,505	7,505	7,505	6,865	100
					Runway 35	7,505	7,505	7,505	7,505	

Notes:

1. Runway 17 has a 640-foot displaced threshold. The threshold of the runway was displaced due to existing obstructions that are located in Runway 17s approach surface. Due to the displacement, the available operational runway length for landings on Runway 17 is less than the full pavement length available. Landing prior to the designated displaced threshold is prohibited. However, the paved area before the displaced threshold (marked by white arrows) is available for aircraft taxiing, landing rollout, and takeoff only. Thus, all takeoff operations would have full pavement length for departures. Due to the existing obstructions and as of December 2004, the completion of a new public roadway, Regional Drive, it is recommended that the existing displaced threshold remain in its current location with any additional length added to the Runway 35 end. The acronyms listed pertain to declared distance information used for calculating maximum operating capacity and are as follows: TORA = takeoff run available (the length of runway declared available after safety parameters are in place), TODA = takeoff distance available (the TORA plus the length of any remaining runway declared available after safety parameters are in place), ASDA = accelerated stop distance available (the length of runway declared available for accelerated stop distance requirements after safety parameters are in place), and LDA = landing distance available (the length of runway declared available for landing distance requirements after safety parameters are in place).
2. Based on runway length analysis of 48 of the most popular business jet aircraft used today. Currently 39 percent of the most popular business jet aircraft are accommodated on the existing 6,005-foot runway. Increases in runway length in turn increase the number of business jet aircraft that can use the runway without weight limitations/restrictions, i.e. at 100 percent useful load (full load of passengers, fuel and baggage/cargo).

Table 3-8: Concord Municipal Airport – Runway 17-35 Length Analysis - Potential Impacts

Alternatives [9]	Runway Pavement Length (feet)	Most popular business jet aircraft accommodated [1] (percent)	Impacts to MALSR [2]	Property Easement or Acquisition Required/Amount to Protect Both the MALSR and RPZ		Approach Impacts	Impacts to Soucook River	Noise Impacts [8]
				Required	Amount (acres)			
Existing	6,005	39	No	No	0	No	No	Yes
1	6,505	75	Yes [3]	Yes [3]	5 [4]	Yes [5]	No	Yes
2	6,755	83	Yes [6]	Yes [6]	7 [4]	Yes [5]	No	Yes
3	7,005	90	Yes [6]	Yes [6]	12 [4]	Yes [5]	No	Yes
4	7,505	100	Yes [6 & 7]	Yes [6 & 7]	27 [4]	Yes [5]	Yes [7]	Yes

Notes:

1. Same as note 2 for Table 3-7 above.
2. A Medium Intensity Approach Light System with Runway Alignment Indicator Lights, or MALSR, is a type of approach lighting system (ALS) that provides pilots with a basic means to transition from instrument flight to visual flight for landing at an airport. The MALSR is a lighting system that begins at the approach end of the runway and extends into the approach path of that runway for 2,400 feet with each light stanchion located at 200-foot intervals. Extension of the runway in each alternative requires the movement of the MALSR to accommodate the new runway threshold and location. Each alternative requires a portion of the approach light system to be located off of airport owned property requiring either the purchase of land or easements to install and maintain the lighting equipment.
3. This alternative requires one MALSR light stanchion (the last one) to be located off of airport property. This alternative also places the RPZ over land not owned by the airport or over land where no easement exists. Thus, property acquisition and/or acquisition of easements are necessary to implement this alternative.
4. Property easements and/or property acquisition is required for each alternative. The acreage depicted includes both the land area needed beneath the RPZ and the land area needed to accommodate the MALSR light stanchion/stanchions
5. Movement and/or extension of Runway 17-35 also moves/extends the Runway 35 approach surface, which must be protected from obstructions and object penetrations such as any manmade objects or objects of natural growth such as trees, brush, and/or terrain (ground penetrations). The analysis indicates that the longer the extension, the more obstructions exist requiring removal or lighting of the obstructions.
6. Similar to alternative 1, alternatives 2, 3 and 4 require property acquisition and/or easements to protect land beneath the RPZ not owned by the airport and to accommodate the MALSR light stanchion installation. Three light stanchions would be located off of airport property in alternative 2, four in alternative 3 and six in alternative 4.
7. The last light stanchion would be located in the Soucook River. An impact that is environmentally undesirable due to the fact that the river is both a wetland and zoned as shoreland protection zone under the City of Concord's zoning ordinance. According to the City, a light stanchion is considered an incompatible use within this zone.
8. Noise impacts associated with aircraft operations at Concord Municipal Airport are evaluated in *Chapter 4 – Environmental Review* of this report. Using runway geometry, forecast operations, typical flight tracks and aircraft types noise contours are created representing areas of noise impact around the airport. The noise contours represent average daily noise levels that occur over a 24-hour period at the airport. The contours identify which areas are likely to have noise concerns. Generally, those areas falling within the 65-decibel contour are considered to be subject to noise disturbance. As the runway length increases within each alternative more land surrounding the airport is incorporated into the 65-decibel contour. See *Chapter 4 – Environmental Review* of this report for further information.
9. See **Figures 3-4 through 3-7** for areas of impact.

Figure 3-3: Runway Length Alternatives – Impacts – 500-Foot Extension

Figure 3-4: Runway Length Alternatives – Impacts – 750-Foot Extension

Figure 3-5: Runway Length Alternatives – Impacts – 1,000-Foot Extension

Figure 3-6: Runway Length Alternatives – Impacts – 1,500-Foot Extension

As indicated in both the tables above and in the attached figures, impacts to the existing approach light system, or MALSR; the need of additional property acquisitions and/or easements; impacts to Runway 35's approach surface; and impacts to nearby communities associated with aircraft noise take place within each alternative, albeit at varying levels. Relocation of the MALSR approach light system and the approach surface would require property easements and/or property acquisition beyond the approach end of Runway 35 for the following reasons:

1. To maintain and install the lighting equipment for the relocated MALSR system; and
2. To protect the new approach surface and RPZ in areas not owned by the airport

As depicted in the *March 1996 Concord Municipal Airport Master Plan Update* future noise contours exist outside of airport owned property, which overlay incompatible land uses such as residential properties. Movement of the threshold within each alternative will shift the noise contours and incorporate additional properties not previously included, thus, potentially impacting nearby communities (see *Chapter 4 – Environmental Review* for further information).

Impacts to the Soucook River exist in alternative 4, only.

Analysis of the runway length alternatives indicates that a 1,000-foot extension is preferred and justifiably reasonable. A review of the factors leading to this determination is included below.

1. Of the four runway length alternatives evaluated for Runway 17-35 (a 500, 750, 1,000 and 1,500-foot runway extension), alternative 4, the 1,500-foot extension (bringing the runway to an overall length of 7,505 feet) cannot be justified for Concord Municipal Airport due to the following:
    a. Aircraft that require a 7,505-foot runway fall into a higher design category such as C-II/D-II. Higher dimensional standards exist for C-II/D-II type aircraft such as the standards for runway safety areas. Logically, if the airport were to provide users with a 7,505-foot runway, it should also provide them with the design standards associated with such a length. The existing and future design category for Concord Municipal Airport is B-II and requires a 300-foot by 150-foot runway safety area. A 1,000-foot by 400-foot runway safety area is the required dimensions for a C-II/D-II airport. At Concord Municipal Airport both a 1,500-foot extension and the standard 1,000-foot by 400-foot runway safety area located beyond runway end can not be met due to extreme differences in elevation, environmental constraints, and cost associated with the fill needed to implement such a project;
    b. The number of operations by aircraft requiring such length at Concord Municipal Airport is minimal. Although C-II/D-II type aircraft operate at the airport, they are a small minority of annual operations. Establishment of a longer runway is not based on a "if you build it, they will come" scenario, but on existing and future aircraft needs, which involve more aircraft that fall into the B-II category as indicated in *Section 2.1 – Protected Surfaces – Airport Design Criteria*, of this chapter; and
    c. Although a 1,500-foot runway extension would accommodate 100 percent of the most commonly used business jet aircraft, the impacts associated with a 1,500-foot extension cannot be justified especially when other alternatives exist. The 1,000-foot extension, which can accommodate 90 percent of the most commonly used business jet aircraft, a relatively small difference when compared to the 1,500-foot extension.
2. Although both the 500-foot, alternative 1, and 750-foot, alternative 2, extensions are more in-line with B-II airport design standards (i.e., runway lengths between 6,000 feet and 6,750 feet support most business jet aircraft that fall into the B-II category), a 1,000-foot extension, alternative 3, would provide the airport with more flexibility. This approach would neither limit potential growth nor would it build more than is necessary for Concord Municipal Airport. In other words, it would provide the airport with the option of expanding a full 1,000 feet in the future, if future activity demands require it, but it would also allow the airport to develop some lesser extension (say a 500-foot or 750-

foot extension) if the 1,000-foot extension were deemed unnecessary. It would allow the airport to develop the overall length in phases based on future needs of the most commonly used business jet aircraft;

3. A 1,000-foot extension would accommodate 90 percent of the most commonly used business jet aircraft and allow them to operate at 100 percent useful load, i.e., without weight limitations, versus 75 percent with a 500-foot extension, alternative 1, or 83 percent with a 750-foot extension, alternative 2;
4. A 1,000-foot extension identifies the maximum runway length that can be reasonably met and still allow for it's associated safety areas and safety zones for either the existing ARC of B-II or an increase in the ARC higher than B-II. For example, a 1,000-foot extension would still allow for the development and creation of a larger safety area if an increase in the ARC is required in the future;
5. Although the 1,000-foot expansion has more impacts associated with it when compared to alternatives 1 and 2, the impacts are reasonably similar with the most significant difference associated with the amount of land and/or easements that would be required to implement the extension.

Given the above analyses, it is recommended that land be preserved to allow for a 1,000-foot expansion, on Runway 17-35. While this length may not be needed immediately, it is recommended that the airport sponsor properly plan to ultimately provide for such an expansion in the future. This includes acquiring land and/or obtaining the necessary easements required to: 1) relocate the approach lighting system; 2) protect the airspace and other safety zones from obstructions/object penetrations; and 3) to provide the airport with the control to remove and/or light those obstructions located within the proposed RPZ and approach surface. It is also recommended that a benefit-cost-analysis be completed prior to project implementation that outlines the following:

- Potential benefits to the aviation public and surrounding community
    - Benefits and costs affecting the aviation public or directly attributable to aviation
- Potential economic benefits
    - Both benefits realized in the form of monetary gains (i.e. increase in fuel sales, fuel taxes and property taxes) and non-monetary resources (i.e. improved travel time, convenience to airport business users)

4.2 Taxiways

The following identifies the condition of Concord Municipal Airport's taxiways and identifies facility improvements where necessary.

4.2.1 Taxiway Pavement Condition

As indicated in *Chapter 1 – Inventory*, Concord Municipal Airport has seven taxiways (one of which is used to access the New Hampshire Army National Guard facility): one parallel taxiway, Taxiway A; four-access taxiways (or stub taxiways) connecting the parallel taxiway to the runway (Taxiways A1 through A4) and two-access taxiways providing access to both the old and new New Hampshire Army National Guard facilities.

Taxiway A was constructed 1975 and reconstructed (the north section only) in 1990. The overall condition of the north section pavement is very good. The four-access taxiways connecting the parallel taxiway to the runway were constructed in 1975. No rehabilitation has taken place on the access taxiways or on the south section of the parallel taxiway since its construction. The south section pavement is in poor to fair condition. A majority of the access taxiway providing access to the old New Hampshire Army National Guard facility was removed in 2004 when Regional Drive was constructed; however a portion is still used by pilots wishing to check their magnetic compass heading against the directional headings provided on the surface painted compass rose located on this taxiway.

Although all public use taxiways have been maintained though basic maintenance and crack sealing, the condition of the taxiways has deteriorated since the pavement evaluation (completed in October of 2003) and should be reevaluated to determine when rehabilitation is necessary. The rule of thumb is a life expectancy of 15 to 20 years. Thus indicating that Taxiway A (the south section) and its four-access taxiways have reached the end of their designed pavement life in 1995 and are overdue for pavement rehabilitation. Recent visits to the airport (June 2005) indicate that crack sealing is no longer a viable option due to extensive movement in the pavement. Such movement that has created cracks in some places to be at least five-inches in depth and three to four-inches in width.

In accordance with the discussion above, it is recommended that Taxiway A (the south section) and its four-access taxiways be scheduled for rehabilitation within the short-term phase of this planning period. Taxiway A (the north section) is due for rehabilitation in 2010.

4.2.2 Airport Design Criteria and Condition

Table 3-2 of this chapter identifies the B-II dimensional design requirements for taxiways. In addition to the dimensional design criteria listed in the table, taxiways also have standards for the condition of each taxiway design element. The following defines taxiway design criteria, identifies the existing conditions for each design element and makes recommendations for improvement for those items not meeting criteria.

Taxiway Width

The B-II taxiway design standard requires a 35-foot taxiway. All taxiways exceed design standard (see *Chapter 1 – Inventory, Table 1-11* for taxiway information). **Although the taxiway widths exceed B-II design standards, reductions are not warranted due to the following:**

1. The additional width allows for ease of maintenance of taxiway edge safety margins (requiring a 7.5-foot margin) and taxiway shoulders (requiring a 10-foot shoulder);
2. The additional width better accommodates larger business jet aircraft (typically requiring larger taxiway widths) that currently operate at Concord Municipal Airport during special events such as NASCAR races; and
3. It is possible that the additional width may be required in the long-term future, i.e., if the type of aircraft or the number of operations by larger jet aircraft that fall into higher design categories were to substantially increase

Taxiway Edge Safety Margins, Shoulders, Safety Areas, and Object Free Areas

The following identifies design standards for taxiway edge safety margins, shoulders, safety areas, and object free areas and makes recommendations for improvement for those items not meeting criteria.

Taxiway edge safety margins are the minimum acceptable distance between the outside of the airplane wheels and the pavement edge.

Taxiway shoulders are designed to provide resistance to blast erosion.[xxv] They are typically designed as paved shoulders and exist to reduce the possibility of blast erosion and engine ingestion problems associated with jet engines, which overhang the edge of the taxiway pavement. Typically, soil and/or turf shoulders are not suitable for this purpose. A low cost paved surface is more desirable.

Taxiway safety areas (TSA) are similar to runway safety areas. The TSA is a rectangular area, centered on the taxiway centerline, which is to remain free of obstacles or rough terrain, except for objects that need to be located in the TSA because of their function, such as navigational aids. The TSA provides a suitable surface that reduces the risk of damage to aircraft in the event that an aircraft leaves the taxiway environment.

The **taxiway object free area (OFA)** surrounds the TSA. Service vehicle roads, parked aircraft, and fixed or moveable objects are prohibited. Only objects that need to be located in the taxiway OFA, because of their function, such as navigational aids, are allowed.

Although the dimensional taxiway design criteria can be met, the following identifies taxiway design elements that cannot be met:

- As indicated above, the TSA is to remain free of rough terrain and provide a suitable surface for an aircraft to travel on in the event the aircraft leaves the taxiway environment. This standard cannot be met due to several large humps in the soil caused by previous snow removal operations and soil erosion due to the clumping of grass that has been caused by the lack of mowing.

In an effort to meet FAA regulations regarding the condition of the TSA, it is recommended that the necessary fill be brought into the area and/or the turf rolled to reestablish a more appropriately graded and suitable surface.

4.2.3 Taxiway Issues

Parallel Taxiway to Runway 12-30

Runway 12-30 is accessible via the closed Runway 03-21, which intersects at the midpoint of the runway, and Taxiway A (the approach end of Runway 12 is accessible via Taxiway A and the approach end of Runway 17). There is no parallel taxiway, or access taxiway, to enter the approach end of Runway 30. Pilots are required to back-taxi approximately 1,320 feet on the runway, from the closed Runway 03-21, to get to the approach end of Runway 30 for takeoff. The *March 1996 Concord Municipal Airport Master Plan Update,*[xxvi] identified the need for a parallel taxiway to avoid back-taxiing. Review of this recommendation indicates that there is still a need for a parallel taxiway for Runway 12-30. Discussions with the airport sponsor (the City of Concord), airport staff, United States Fish and Wildlife Service, and the New Hampshire Fish and Game Department indicate that the parallel taxiway should be located on the south side of Runway 12-30 for the following reasons:

1. To be consistent with past planning recommendations; and
2. To be consistent with the Conservation Management Agreement (see *Chapter 4 – Environmental Review* for further information) and the conservation and development zones, which designate development of a future parallel taxiway on the south side of Runway 12-30

A parallel taxiway to Runway 12-30 continues to be recommended, as described above, and identified on the ultimate airport layout plan.

Convert the Closed Runway, Runway 03-21, Into A Taxiway/Ramp

Following the closure of Runway 03-21, the paved area has historically been used for overflow aircraft parking during special events such as NASCAR races. The *March 1996 Concord Municipal Airport Master Plan Update,*[xxvii] identified conversion of this 150-foot pavement into a 35-foot taxiway.

Review of this recommendation indicates that the closed runway should be converted into a taxiway, albeit maintaining its existing width of 150 feet due to the fact that the area is used as overflow parking of larger business jet aircraft and two Boeing 727s during NASCAR race weekends. Although recommendations within this chapter identify the development of additional aircraft storage ramps to accommodate those aircraft, overflow parking for large aircraft is still necessary. A 35-foot taxiway will not accommodate those larger aircraft. **Therefore, it is recommended that the entire width (150 feet) of closed runway be converted to a taxiway/ramp. It is also recommended that the pavement be rehabilitated (as of July 2004 the condition of the pavement was fair) and strengthened to support the larger business jet aircraft.**

4.3 Visual and Navigational Aids

Visual Aids include any visual device on the airport surface, which provides guidance information or position data guidance to pilots maneuvering on airports. They include airport markings on paved runways, taxiways, ramps and roadways; airport lighting; and airport signs.

Navigational Aids (Navaids) include any visual or electronic device airborne or on the surface which provides point-to-point guidance information or position data to aircraft in flight.[xxviii]

Chapter 1 – Inventory, Tables 1-10 and 1-11, identifies Concord Municipal Airport's visual and navigational aids, while the following identifies the condition of those aids and known issues. This section also recommends facility improvements where necessary.

Visual Aids – Marking Paved Areas - Runways

Advisory Circular (AC) 150/5340-1J, Standards for Airport Marking, provides the standards for marking paved areas on airports (runways, taxiways, ramps, and roadways). **Table 3-9** identifies runway markings that are required for Concord Municipal Airport based on the type of runway approach, i.e., precision, non-precision, or visual.

Table 3-9: Required Runway Marking Elements

Runways	Runway 17	Runway 35	Runway 12	Runway 30
Approach Type	**Non-Precision**	**Precision**	**Non-Precision**	**Visual**
Runway Length (feet)	**6,005**		**3,200**	
Runway Marking Element				
Designation	X	X	X	X
Centerline	X	X	X	X
Threshold marking	X	X	X	X [1]
Aiming Point	X [2]	X	X [2]	X [2]
Touchdown Zone		X		
Side Stripes	X [3]	X	X [3]	X [3]
Holding Position Markings on Runways			X [4]	

Source: *Advisory Circular (AC) 150/5340-1J, Standards for Airport Marking*[xxix]

Notes:

1. Only required on runways used, or intended to be used, by international commercial transport.
2. On runways 4,000 feet (1200 m) or longer used by jet aircraft.
3. Used when the full pavement width may not be available as a runway.
4. These markings are installed on a runway normally used as a taxiway such as Runway 12-30.

Analysis of the existing runway markings indicates that for the most part Concord Municipal Airport has the required pavement markings, with the exception of aiming point markings on Runway 17. **Therefore, it is recommended that the airport paint the aiming point marker on Runway 17.**

The pavement markings on Runway 17-35 are faded and yellow, while the pavement markings on Runway 12-30 are in very good condition**. In an effort to maintain runway marking visibility, it is recommended that the airport repaint their runway markings on a regular basis.** According to discussions with several airport managers within the New England region,[xxx] the most common repainting schedules are either an annual rotating paint schedule, or a tri-annual paint schedule. An annual rotating paint schedule includes painting some, but not all, airport surfaces annually, i.e., all taxiways in the first year, runways in the second,

and ramps in the third followed by taxiways again, etcetera. A tri-annual paint schedule includes repainting all paved surfaces every three years.

During the airport safety and compliance inspection completed by the FAA on July 21, 2004[xxxi] (see **Appendix E** for the compliance inspection letter), **it was recommended that side stripes be painted at the intersection of Runway 12-30 and the old runway to help prevent inadvertent entry**.

Visual Aids – Marking Paved Areas - Taxiways

Table 3-10 identifies the taxiway markings that are recommended/required for Concord Municipal Airport.

Table 3-10: Taxiway Marking Elements

Taxiway Marking Element	Recommended	Required
Taxiway Centerline		X
Enhanced Taxiway Centerline	X	
Taxiway Edge	X	
Runway Holding Position		X
Runway Holding Position for an Instrument Landing System		X
Surface Painted Holding Position Signs	X	
Surface Painted Apron Entrance Point Signs	X	

Source: *Advisory Circular (AC) 150/5340-1J, Standards for Airport Marking*[xxxii]

Review of the required and recommended taxiway pavement markings, indicates that the airport has most of the required markings necessary with the exception of the runway holding position marking for the instrument landing system (ILS). **Therefore, it is recommended that an ILS hold position marking be painted on Taxiway A.** This recommendation was also made during the FAA compliance inspection.

The taxiway pavement markings are poor. Similar to the runway paint markings, **it is recommended that the airport repaint their taxiway markings on a regular basis in an effort to maintain marking visibility, especially the runway hold position markings.**

Visual Aids – Marking Paved Areas – Other Markings

Table 3-11 identifies the other pavement markings, other than runway and taxiway markings, that are recommended/required.

Table 3-11: Other Marking Elements

Other Marking Element	Recommended	Required
VOR Receiver Checkpoint (Compass Rose)		X
Marking and Lighting of Permanently Closed Runways and Taxiways		X
Converting a Runway to a Taxiway		X

Source: *Advisory Circular (AC) 150/5340-1J, Standards for Airport Marking*[xxxiii]

During the FAA's compliance inspection[xxxiv] the following "other" marking improvements were recommended and should be implemented at Concord Municipal Airport:

- Repaint the VOR checkpoint if the VOR is to remain active;
- Remove all markings on the closed runway with the exception of the yellow "X" demoting that the runway is closed. Removal of the marking should be done through sand blasting rather than simply blacking out the marking; and
- Use glass beads in yellow and white paint markings as indicated in *AC 150/5340-1J, Standards for Airport Marking*.
    - According to *AC 150/5340-1J*,[xxxv] "Markings that cannot be seen by pilots and others operating on marked surfaces are useless."[xxxvi] Outlining pavement markings in black or applying glass beads (glass beads should not be used in conjunction with the black paint) are two of the most common methods used to increase the visibility of markings at airports. Outlining all edges of the marking with a black border increases the visibility of markings situated on light colored pavement surfaces such as concrete. On the other hand, glass beads have also been used to highlight pavement markings and to increase marking visibility during nighttime operations, low visibility conditions and during periods when the pavement surface may be wet.

Visual Aids – Airport Lighting

Advisory Circular (AC) 150/5340-30A, Design and Installation Details for Airport Visual Aids, provides guidance and recommendations on the installation of airport visual aids such as runway and taxiway lights, rotating beacons, lighted wind cones, obstruction lights, economy approach light systems, etcetera. This AC is used to identify airport lighting needs and to recommend facility improvements where necessary. Concord Municipal Airport's existing visual and navigational aids are identified in *Chapter 1 – Inventory, Tables 1-10 and 1-11*, of this airport master plan update report.

Table 3-12 lists the airport lighting aids that should be upgraded and/or established for Concord Municipal Airport.

Table 3-12: Visual Aids to be Upgraded and/or Established at Concord Municipal Airport

Visual Aid to be Upgraded/Established	Recommendation
Medium Intensity Taxiway Lights (MITLs)	Taxiway A, the parallel taxiway serving Runway 17-35 does not have taxiway edge lighting. According to *AC 150/5340-30A, Design and Installation Details for Airport Visual Aids,*[xxxvii] medium intensity taxiway lights (MITLs) are recommended for taxiways and ramps on airports using medium intensity runway lights (MIRLs) or high intensity runway lights (HIRLs). Runway 17-35 has HIRLs. **In an effort to improve the utility of the airport during nighttime operations and to increase visibility during low visibility weather conditions, installation of MITLs are recommended for Taxiway A and it's four-access taxiways. It is also recommended that until the lights can be installed, that low cost taxiway retroreflective markers be installed (see *AC 150/5345-39, FAA Specification L-853, Runway and Taxiway Retroreflective Markers*). MITLs are also recommended for the proposed parallel taxiway to access Runway 12-30.**
Taxiway Centerline Lights	Although taxiway centerline lighting typically is not required at general aviation airports (most taxiway centerline lighting is for airports with air carrier operations), installation is recommended where a taxiing problem exists to improve guidance for complex taxiway configurations.[xxxviii] The intersection of Runway 17 and 12 may qualify for such installation. **Although a costly alternative, it is recommended that taxiway centerline lighting be installed at Taxiway A1 to enhance taxiway centerline visibility. A less costly alternative is the installation of low-cost retroreflective taxiway centerline markers.**
Supplemental Windsocks	Discussions with the airport tenants/users indicate a need for supplemental wind direction indicators for Runways 30 and 35. The source of wind information on an airport that is reported to pilots may be 2 to 3 miles from the approach end of a runway. Factors such as topography and weather could result in different wind conditions near runway ends than reported to pilots. Under such circumstances, supplemental windsocks provide pilots with a continuous visual indication of wind conditions. **Therefore, in an effort to meet the goals and objectives of airport tenants/users, and to enhance safety, it is recommended that supplemental windsocks be provided at the approach ends of Runway 30 and 35.**
Runway End Identifier Lights (REILs) and Precision Approach Path Indicators (PAPIs)	Economy approach lighting aids were developed to make visual aids available to airports at a low cost. The FAA recommends the installation of low-cost economy approach lighting aids on runways where the visibility is greater than 1-statute mile. Lighting aids such as REILs and PAPIs provide better visibility for pilots approaching the runway end for landing. REILs aid in early identification of the runway and runway end.[xxxix] And they are beneficial in areas having a large concentration of lights such as the lights from commercial businesses surrounding the airport. The PAPIs provides visual approach slope guidance to the runway touchdown area. The PAPI was designed to replace the visual approach slope indicator (VASI) due to several shortcomings of the existing VASI system and to provide more stable and accurate tracking to final approach. The PAPI was accepted and certified in 1981 by the International Civil Aviation Organization (ICAO), while the VASI system lost its ICAO certification in 1995. Runways 17 and 12, both non-precision approaches, would benefit from such low-cost economy approach lighting aids. Runway 17 has REILs but they are inoperative and have been since 1986 due to the removal of the power source. **Therefore, in an effort to improve the visibility of an approach to Runway 17, it is recommended that REILS be reestablished and the power source provided. Likewise, it is recommended that REILS be installed at the approach end of Runway 12 to improve visibility and to enhance the approach for that runway.** The VASI, located at the approach end of Runway 35, may be difficult to maintain in the future because system parts are no longer manufactured. **Although Runway 35 has a much more sophisticated approach lighting aid (the MALSR), it is recommended that the VASI be replaced with the newer and more advanced PAPI system.** The installation of these systems would not reduce visibility minimums for either runway; however, such systems aid pilots in locating the approach end of a runway and enhance the pilot's visibility of the runway environment, thus enhancing the safety of the non-precision or visual approach.

Visual Aids – Airport Signs

Advisory Circular (AC) 150/5340-18D, Standards for Airport Sign Systems, provides the standards for runway and taxiway signs on airports.

According to *AC 150/5340-18D, Standards for Airport Sign Systems*, a properly designed and standardized runway and taxiway guidance sign system is essential to allow both aircraft and ground vehicles to easily determine where they are on the airport. Runway and taxiway signs should easily identify the designation or name of any taxiway or runway on which the aircraft or ground vehicle is located. The signs should readily identify routes toward a desired destination such as a directional sign indicating the route to the ramp for aircraft parking or to another runway or taxiway. Airport signs should also indicate mandatory holding positions when operating during low-visibility weather operations and to identify boundaries for approach areas, Instrument Landing System (ILS) critical areas, etcetera.

The taxiway and runway signs at Concord Municipal Airport are in poor condition and are confusing. During the inventory phase of this master Plan update (July 2004) it was noted that some of the sign panels were falling off or were the wrong size. Some were also faded, unlit, covered with grass and generally hard to read. Being aware of the problem, the airport asked that a sign plan be completed as part of this airport master plan update. The sign plan is available for review in *Chapter 5 – Airport Plans* of this report. **Replacement of the existing signs and installation of new signs is recommended based on the aforementioned established sign plan.**

Navigational Aids

Chapter 1 – Inventory, Table 1-10, identifies Concord Municipal Airport's navigational aids. Discussions with airport tenants and users indicated that the existing systems in place are adequate for existing and future operations. **Therefore, additional navigational aids are not warranted and, thus, are not recommended within this planning period for Concord Municipal Airport. However, navigation to the airport could be improved if obstructions within the approach for Runway 35 were removed.** If the obstructions are removed it is possible that the visibility minimums could be reduced as detailed in the following sections.

4.4 Airside Obstructions/Imaginary Surfaces

As indicated earlier in this chapter, FAR Part 77, *Objects Affecting Navigable Airspace*,[xl] establishes imaginary surfaces above airports to protect navigable airspace from objects/obstructions that may penetrate the airspace.

During a site visit to Concord Municipal Airport and the completion of an obstruction study of the runway approaches (completed in October 2004) the existing and potential future imaginary surface obstructions were noted.

A graphic depiction of the airport imaginary surfaces and imaginary surface obstructions is shown in *Chapter 5 – Airport Plans*.

In an effort to enhance safety, it is recommended that clearing and grubbing of trees, brush, and terrain located both on and off of airport property within the airport's imaginary surfaces take place within this planning period. If trees and/or terrain cannot be removed, it is recommended that the areas be identified with obstruction beacons/lighting. Although the airport currently has some avigation easements for those areas of impact, additional avigation easements are required and must be obtained prior to the removal of obstructions that are located off of airport property.

5.0 Storm Water Pollution Prevention Plan (SWPPP)

The purpose of a SWPPP is to identify sources of pollution potentially affecting the quality of storm water discharges associated with industrial activity at an airport and to ensure implementation of practices to minimize and control pollutants in storm water discharges. A SWPPP is a continuously updated plan providing data regarding new sources of pollution and/or changes in practices to minimize and control those pollutants.

A SWPPP is being completed concurrently with this master plan update. A final plan is available for review at the airport through Concord Aviation Services or through the City of Concord's Community Development Department.

The plan includes the following:

- An inventory of the activities at the airport;
- Identification of site drainage patterns;
- Recommendations for corrective and/or protective measures;
- Creation of a model for inspection, compliance evaluation and documentation; and
- Suggestions that present a method to maintain and upgrade the SWPPP as conditions and/or facility usage changes

The inventory of airport activities includes a review of facilities located at the airport and sources of potential pollution from those facilities. It identifies materials and chemicals stored or handled at each of those facilities.

Drainage patterns are identified to determine the direction of drainage to storm water from each airport facility. Review of those patterns indicate that storm water leaves the Concord Municipal Airport both through closed drainage systems and by overland sheet flow. All of the water is either recharged to the sandy soils of the airport or flows to the Atlantic Ocean via the Merrimack River. On a local scale, the run-off either flows to the Merrimack River on the west or to the Soucook River on the east, which in turn joins the Merrimack River south of the airport.

In an effort to minimize contact with storm water and to prevent discharge of oil into navigable waters of the United States, best management practices and pollution prevention and control measures should be implemented.

According to the Environmental Protection Agency (EPA)[xli] and regulations issued under the Clean Water Act, transportation facilities are required to prepare a Spill Prevention Control and Countermeasures (SPCC) Plan if: 1) the facility stores oil in bulk; and 2) the facility is located in an area where storm water runoff drains into navigable waters of the United States. The SPCC is to be prepared by the owner/operator of a facility that falls under the SPCC rule. A facility may be subject to SPCC rule if it has at least one of the following bulk oil storage capacities:

1. If a facility has a total aboveground oil storage capacity greater than 1,320 gallons; or
2. If a facility has a completely buried oil storage capacity greater than 42,000 gallons

Analysis of the facilities located at the airport and the list of materials and chemicals stored or handled at each indicates that a SPCC Plan is required for Concord Aviation Services.

6.0 Airport Security/Wildlife Fencing Requirements

As indicated in *Chapter 1 – Inventory*, the airport's security fence encompasses approximately 2/3 of airport property. The southeastern boundary is not fenced due to terrain and safety issues.

Although airport security fencing is not required under current FAA regulations for Concord Municipal Airport, it is advised by the FAA that the nation's airports provide security fencing as public protection in order to prevent possible wildlife hazards and inadvertent entry to the airport movement area (runways and taxiways) by unauthorized persons or vehicles. Also, increased security awareness is warranted in the wake of the September 11, 2001 attacks.

Therefore, it is recommended that the remaining 1/3 of the airport's property boundary be fenced.

7.0 Perimeter Road Requirements

In an effort to maintain a separation between automobiles and aircraft and to avert runway incursions, airports around the nation have constructed perimeter airport roads. Perimeter roads are made available at airports so that airport ground vehicles such as fuel, maintenance, and operations vehicles can move between areas on the airport avoiding the need to cross runways and taxiways. Discussions with City and airport staff, United States Fish and Wildlife Service, the New Hampshire Fish and Game Department, the Concord Municipal Airport Advisory Board and the PAC indicate a need for a perimeter road at Concord Municipal Airport. This road is not a public access road. It is strictly used for airport personnel and occasional emergency vehicles.

Discussions with the United States Fish and Wildlife Service and the New Hampshire Fish and Game Department indicate that the construction of a perimeter road is advantageous to them because it would not only provide better separation between aircraft and ground vehicles, it would also provide their scientists with a designated roadway to access the airport to monitor and manage habitat for the Karner Blue Butterfly (see *Chapter 4 – Environmental Issues* for further information).[xlii]

In an effort to increase safety at the airport, to reduce the possibility of runway incursions, and to meet the airport's goals, it is recommended that a perimeter road be constructed at the airport. A turf roadway is preferred so that little maintenance is required and so that the area can still be used for the growth and protection of the Karner Blue Butterfly. A portion of a turf type perimeter road exists west of the parallel taxiway, Taxiway A, from the based aircraft storage ramp (south ramp) to the approach end of Runway 35. The airport desires to continue this road on the east side of the airport.

8.0 Snow Removal Equipment Requirements

This section analyzes snow removal equipment requirements at Concord Municipal Airport.

According to *AC 150/5220-20, Airport Snow and Ice Control Equipment*,[xliii] the minimum snow removal equipment required for an airport is determined by: 1) the type airport (commercial or non-commercial); 2) the number of annual operations; and 3) the amount of annual snowfall.[xliv]

Concord Municipal Airport is considered a non-commercial service airport with approximately 55,234 reported annual operations for 2004, and an average of 64.6 inches of annual snowfall reported by the National Weather Service – Eastern Region Headquarters weather web site for Concord, New Hampshire from 1971 through 2000.

According to *AC 150/5220-20*,[xlv] and the data provided above, the existing and future minimum snow removal equipment requirements for Concord Municipal Airport are as follows:

- One high-speed rotary plow, which may be self propelled or attached to a supporting, all-wheel drive, carrier vehicle;[1]
- Two displacement plows of equal capacity, two all-wheel drive carrier vehicles to support the two displacement plows and accessories; and [1]
- Support equipment such as sweepers, wheel loaders and material spreaders to complete the removal of snow from all operational areas including secondary runways, taxiways or ramps

The airport currently has the following snow removal equipment (SRE):

- 1 - 1965 Tractioneer snow blower (military surplus); [2]
- 1 - 1999 International 10-wheel dump truck with 12-foot front plow and double 14-foot wing plows; [3]
- 1 - 1998 John Deere 644H loader with a 20-foot push plow, 20-foot angle plow, a 8-yard snow bucket, and a 3-yard standard bucket; [3]
- 1 - 1988 1- ton truck with front plow (military surplus); [2]
- 1 - 2002 1 - ton material spreader for deicing applications; [3]
- 1 - 2003 Oshkosh snow blower; [3] and
- 1 - 2003 Sweepster towed type sweeper broom [3]

Comparison of the primary and secondary snow removal areas with the existing equipment indicates that for the most part the airport has the equipment required to remove snow at Concord Municipal Airport without the need to purchase additional equipment. However, some of the dated pieces of equipment should be replaced. Discussions with the City[xlvi] indicate that there is a need to maintain a better equipment replacement schedule. In the recent past, the airport's dated snow removal equipment has historically cost more to maintain than to simply reinvest in new equipment. **Therefore, it is recommended that typical life expectancies of each piece of equipment be monitored and new equipment ordered in a timely fashion**. A review of the factors leading to these recommendations is included below.

8.1 Snow Removal Equipment Needs Analysis

Table 3-13 identifies both the primary and secondary snow removal areas as detailed in the airport's winter operations plan.[xlvii]

[1] By FAA definition, a rotary plow, also called a snow blower, is used to cast heavy concentrations of snow away from airport operational areas such as runways and taxiways. A displacement plow is described as a plow with a cutting edge to shear snow from the pavement.
[2] Purchased through government surplus programs
[3] Purchased with FAA AIP grants

Table 3-13: Existing Snow Removal Areas

Snow Removal Areas – First Priority	Approximate Area (square feet)
Runway 17-35 (6,005 feet by 100 feet)	600,500
Taxiway A (6,005 feet by 50 feet)	300,250
Taxiway "Stub" A1 (300 feet by 50 feet)	15,000
Taxiway "Stub" A2 (300 feet by 50 feet)	15,000
Taxiway "Stub" A3 (300 feet by 50 feet)	15,000
Taxiway "Stub" A4 (300 feet by 75 feet)	22,500
Total primary area to be cleared [1]	**968,300**
Snow Removal Areas – Second Priority	
Terminal Ramp to Based Aircraft Ramp (75,000 square feet + 140,000 square feet)	215,000
Ramp in front of State Police Hangar (70 feet by 50 feet)	3,500
Driveway entrances (approximate square footage for the four access roads located along Airport Road)	12,000
Terminal automobile parking lot (25,500 square feet + 3,400 square feet)	28,900
Total secondary area to be cleared	**259,400**

Notes:
1. Rounded to the nearest 100

The existing snow removal equipment, the primary and secondary snow removal calculations and the sample graphical solutions provided in *AC 150/5220-20, Airport Snow and Ice Control Equipment*, are used to determine the airports snow removal equipment needs.

Snow Blower Equipment Requirements for Concord Municipal Airport

Using *Figure 2-4* from *AC 150/5220-20, Airport Snow and Ice Control Equipment*[xlviii] and the assumptions listed below indicates that either two Class I or one Class II rotary plow is required for Concord Municipal Airport to effectively remove snow from the primary surface areas.

Assumptions used to determine rotary plow needs -

- Snow depth = 1 inch
- Plow efficiency = 70 percent
- Snow density = 25 pounds per cubic foot
- 40,000 or more annual operations
- 900,000 to 1,000,000 square feet of primary surface area to be cleared

The airport's 1965 Tractioneer snow blower and the 2003 Oshkosh snow blower provide the necessary equipment to effectively remove snow at Concord Municipal Airport and meet the minimum equipment requirements for a rotary plow. **Although the requirements can be met with the existing equipment, replacement of the 1965 Tractioneer snow blower is recommended due to its age and to meet the concerns of City staff in regards to replacing dated equipment.**

Displacement Plow Equipment Requirements for Concord Municipal Airport

Using *Figures 3-2, 3-3, 3-4, and 3-6* from *AC 150/5220-20, Airport Snow and Ice Control Equipment*[xlix] and the assumptions listed below indicates that at least two 12 foot displacement plows with carrier vehicles is required for Concord Municipal Airport to effectively remove snow from the primary surface areas.

Assumptions used to determine displacement plow needs -

- Snow displacement in tons per hour = 1,300 tons per hour
- Operating speed = 15 to 30 mph (an average of 20 mph assumed)
- Plow efficiency = 70 percent
- Blade cutting angle

The airport's existing equipment exceeds the minimum equipment requirements for displacement plows. Thus, the purchase of additional displacement plows is not necessary.

Support Equipment Requirements for Concord Municipal Airport

Supplemental support equipment such as the 2002 1 - ton material spreader and the 2003 Sweepster, a towed type sweeper broom, provide the airport with the additional support equipment needed to effectively remove snow from all operational areas including secondary runways, taxiways or ramps. **Therefore, additional support equipment is not necessary.**

9.0 Airport Improvements – Preferred Development

Table 3-14 outlines the airport projects identified within this chapter that will allow Concord Municipal Airport to upgrade existing airport facilities; accommodate projected planning activity levels outlined in *Chapter 2 – Aviation Demand Forecasts*; meet airport design criteria and accommodate the goals and objectives of the City of Concord, the airport advisory committee, airport tenants, airport users, NHDOT and the FAA.

Some of the development projects should be completed in conjunction with other projects as a logical sequence of development and to reduce the cost for such development. Where that is the case, it is indicated within the table.

Table 3-14: Preferred Airport Development – Concord Municipal Airport

Landside Facility Requirements/Improvements
Ramp Pavement Rehabilitation
Rehabilitate based aircraft storage ramp (estimated date for rehabilitation – 2011)
Rehabilitate itinerant aircraft storage ramp (estimated date for rehabilitation – 2011)
Aircraft Storage Facilities
Construct based aircraft storage hangars and rehabilitate or replace hangars 1, 2, and 3
Expand itinerant aircraft storage ramp with concrete paving material to accommodate larger jet aircraft such as the occasional use by Boeing 727's
Automobile Parking Storage Facilities
Expand and redesign the existing automobile parking lot located in front of the terminal building creating access from both Airport Road and Regional Drive
Create a turf parking lot for overflow automobile rental and fan parking
Terminal Facility
Demolish and construct a new 9,000 square foot terminal facility in the location of the existing facility
Fuel Facilities
Install an additional 18,000 gallon Jet-A fuel tank during rehabilitation of the based or itinerant aircraft ramps
Airside Facility Requirements/Improvements
Runway 17-35 Improvements
Rehabilitate Runway 17-35 and remove 25-foot shoulders (estimated date for rehabilitation – 2010)
Determine ultimate Runway visibility minimums for Runway 35
Extend Runway 17-35 by 1,000 feet on the 35 end and relocate the approach light system (the MALSR)
Runway 12-30 Improvements
Rehabilitate Runway 12-30 (estimated date for rehabilitation – 2022)
Intersection of Runways 17 and 12
Provide better marking, signage, lighting and overall maintenance at the intersections of Runway 17 and 12
Runway Protection Zone Improvements
Acquire property or obtain easements within the RPZ for Runway 12, 17 and ultimately 35
Improvements for Runway Shoulders, Blast Pads, Safety Areas (RSA), Object Free Areas (OFA) and Obstacle Free Zones (OFZ)
Fill and re-seed the terrain within the runway shoulders, runway blast pads and runway safety areas of both runways
Remove the small trees growing within the RSA, OFA and OFZ of both runways
Fill and re-grade the terrain surrounding airfield sign bases and light bases
Update mowing schedule within conservation zones

Taxiway Improvements
Rehabilitate Taxiway A (south section) and its four stub taxiways (estimated date for rehabilitation – 2005/2006). Rehabilitate Taxiway A, the north section (estimated date for rehabilitation – 2010)
Fill and reseed the taxiway safety area to reestablish a more appropriately graded and suitable surface.
Construct a full-length parallel taxiway to Runway 12-30 and install medium intensity taxiway lights (MITLs)
Realign the stub taxiway, Taxiway A1
Convert the closed runway, Runway 03-21, into a taxiway/ramp and rehabilitate the pavement
Visual and Navigational Aid Improvements
Repaint runway, taxiway and ramp markings every three years.
Paint an aiming point marker on Runway 17 to meet paint marking standards for the non-precision runway
Paint side stripes at the intersection of Runway 12-30 and the old runway until this area is converted into a taxiway/ramp, which at such a time, runway hold markings should be painted
Paint an ILS hold position marking on Taxiway A
Repaint the VOR checkpoint/compass rose
Remove all markings on the closed runway with the exception of the yellow "X" demoting that the runway is closed
Use glass beads in yellow and white paint markings as indicated in *AC 150/5340-1J, Standards for Airport Marking*
Visual Aids – Airport Lighting
Install MITLs for Taxiway A, it's four-access taxiways and the proposed parallel taxiway to Runway 12-30
Install taxiway centerline lighting or low cost retroreflective centerline markers at Taxiway A1
Install supplemental windsocks at the approach ends of Runway 30 and 35.
Reestablish the REILS for Runway 17 and install REILS at the approach end of Runway 12
Replace Runway 35's VASI with the newer and more advanced PAPI system.
Visual Aids – Airport Signs
Replace existing airport signs and install new as necessary per the established sign plan
Airside Obstructions/Imaginary Surfaces
Remove airport obstructions as indicated
Airport Security/Wildlife Fence
Install airport security/wildlife fencing
Airport Perimeter Road
Install a turf perimeter road
Other
Complete an SPCC Plan for Concord Aviation Services
Replace the 1965 Tractioneer snow blower with a new modern piece of equipment

Endnotes

[i] Rist-Frost-Shumway Engineering, P.C. in collaboration with Greiner, Inc. and Applied Economic Research, *Concord Municipal Airport Master Plan Update*, Rist-Frost-Shumway Engineering, P.C., Laconia, New Hampshire, March, 1996.

[ii] U.S. Department of Transportation, Federal Aviation Administration, *Federal Aviation Regulations, Part 77, Objects Affecting Navigable Airspace*, U.S. Government Printing Office, Washington, DC, March, 1993.

[iii] Fink, Rick. (SEA Consultants, Inc.) Phone Interview. April 14, 2005.

[iv] U.S. Department of Transportation, Federal Aviation Administration, *Airport Design, AC No. 150/5300-13, Change 8*, U.S. Government Printing Office, Washington, DC, September, 2004, pp. 56 - 57.

[v] U.S. Department of Transportation, Federal Aviation Administration, *Airport Design, AC No. 150/5300-13, Change 8*, U.S. Government Printing Office, Washington, DC, September, 2004, p. 118.

[vi] Rolla, David. (Concord Aviation Services). Telephone conversation. Monday June 13, 2005.

[vii] Rist-Frost-Shumway Engineering, P.C. in collaboration with Greiner, Inc. and Applied Economic Research, *Concord Municipal Airport Master Plan Update*, Rist-Frost-Shumway Engineering, P.C., Laconia, New Hampshire, March, 1996. p. 4-10.

[viii] U.S. Department of Transportation, Federal Aviation Administration, *Airport Design, AC No. 150/5300-13, Change 8*, U.S. Government Printing Office, Washington, DC, September, 2004, p. 117.

[ix] Zantop, Dave (Staff – Roush Racing). Personal Interview. September 7, 2004.

[x] American Concrete Pavement Association, Pavement Technologies, *Concretes Advantages*, < http://www.pavement.com > (January 26, 2005).

American Concrete Pavement Association, *Concrete Information, Concrete Pavement for General-Aviation, Business and Commuter Aircraft*, Washington, DC, 2002, p. 1.

[xi] Amaral, Michael. (Endangered Species Specialist, United States Department of the Interior, U.S. Fish and Wildlife Service – New England Field Office) Meeting at Concord City Hall. March 16, 2005.

[xii] Goulet, Celine. (New Hampshire Fish and Game Department) Meeting at Concord City Hall. March 16, 2005.

[xiii] Nicosia-Rusin, Ralph. (Federal Aviation Administration – Airports). Personal Interview. February 3, 2005.

[xiv] U.S. Department of Transportation, Federal Aviation Administration, *Advisory Circular (AC) 150/5360-9, Planning and Design of Airport Terminal Facilities at Nonhub Locations*, U.S. Government Printing Office, Washington, DC, April 4, 1980, pp. 11 – 18.

[xv] Rist-Frost-Shumway Engineering, P.C. in collaboration with Greiner, Inc. and Applied Economic Research, *Concord Municipal Airport Master Plan Update*, Rist-Frost-Shumway Engineering, P.C., Laconia, New Hampshire, March, 1996, pp. 6-1 to 6-4.

[xvi] Rist-Frost-Shumway Engineering, P.C. in collaboration with Greiner, Inc. and Applied Economic Research, *Concord Municipal Airport Master Plan Update*, Rist-Frost-Shumway Engineering, P.C., Laconia, New Hampshire, March, 1996, p. 6-1.

[xvii] In order to properly size each of the individual terminal components, an understanding of the likely number of people using the terminal at a given time must be established. The FAA recommends using the Typical Peak Hour

Passenger (TPHP) value for this purpose. In general terms, the calculation of this value is used to establish the total number of people the terminal is designed to handle at a single time.

[xviii] U.S. Department of Transportation, Federal Aviation Administration, *Advisory Circular (AC) 150/5360-9, Planning and Design of Airport Terminal Facilities at Nonhub Locations*, U.S. Government Printing Office, Washington, DC, April 4, 1980.

[xix] Mitchell, Sean (Fire Fighter at Concord Heights Fire Station). Personal Interview. January 27, 2005.

[xx] Based on discussions with Sean Mitchell, the vehicle/equipment bays includes four 12-foot wide by 80-foot deep bays and living space, which includes the following:

- Four work spaces;
- Living room/day room;
- Exercise room;
- Unisex bathrooms with laundry and shower facilities;
- Sleeping quarters for up to ten personnel;
- Dinning room for up to 10 personnel; and
- Kitchen

[xxi] U.S. Department of Transportation, Federal Aviation Administration, *Airport Design, AC No. 150/5300-13, Change 8*, U.S. Government Printing Office, Washington, DC, September, 2004, p. 21.

[xxii] It was noted by FAA staff that the clumping grass and soil erosion is due to the airport's inability to mow and maintain the area due to the existing Conservation Management Agreement (see *Chapter 4 – Environmental Review* for further information).

[xxiii] Laurie J. Hyman, memorandum for Mr. Duncan Ballantyne, City Manager, City of Concord, "Concord Municipal Airport Compliance Inspection", 19 August 2004.

[xxiv] Federal Aviation Administration, *FAA Aerospace Forecasts, Fiscal Years 2004 – 2015*, < http://apo.faa.gov/foreca03/Table%20of%20Contents%2004.htm> (March 11, 2005).

[xxv] U.S. Department of Transportation, Federal Aviation Administration, *Airport Design, AC No. 150/5300-13, Change 8*, U.S. Government Printing Office, Washington, DC, September, 2004, p. 33.

[xxvi] Rist-Frost-Shumway Engineering, P.C. in collaboration with Greiner, Inc. and Applied Economic Research, *Concord Municipal Airport Master Plan Update*, Rist-Frost-Shumway Engineering, P.C., Laconia, New Hampshire, March, 1996, p. 4-5.

[xxvii] Rist-Frost-Shumway Engineering, P.C. in collaboration with Greiner, Inc. and Applied Economic Research, *Concord Municipal Airport Master Plan Update*, Rist-Frost-Shumway Engineering, P.C., Laconia, New Hampshire, March, 1996, p. 6-7.

[xxviii] Welcome to SmartRegs – Interactive FAR, *Smart Regs Glossary* – Navigational Aid, <http://www.smartregs.com/data/sa373.htm> (May 19, 2005).

[xxix] U.S. Department of Transportation, Federal Aviation Administration, *Standards for Airport Marking, AC No. 150/5340-1J*, U.S. Government Printing Office, Washington, DC, April 29, 2005, pp. 3-8.

[xxx] Diane Cooper laa@metrocast.net, "Airfield Painting," May 20, 2005, email/office communication (May 20, 2005).

Robert Cossette bhbairport@acadia.net, "Airfield Painting," May 20, 2005, email/office communication (May 20, 2005).

Evan McDougal ermcdougal@sanfordmaine.org, "Airfield Painting," May 20, 2005, email/office communication (May 20, 2005).

[xxxi] Laurie J. Hyman, memorandum for Mr. Duncan Ballantyne, City Manager, City of Concord, "Concord Municipal Airport Compliance Inspection", 19 August 2004.

[xxxii] U.S. Department of Transportation, Federal Aviation Administration, *Standards for Airport Marking, AC No. 150/5340-1J*, U.S. Government Printing Office, Washington, DC, April 29, 2005, pp. 8-16.

[xxxiii] U.S. Department of Transportation, Federal Aviation Administration, *Standards for Airport Marking, AC No. 150/5340-1J*, U.S. Government Printing Office, Washington, DC, April 29, 2005, pp. 17-19.

[xxxiv] Laurie J. Hyman, memorandum for Mr. Duncan Ballantyne, City Manager, City of Concord, "Concord Municipal Airport Compliance Inspection", 19 August 2004.

[xxxv] U.S. Department of Transportation, Federal Aviation Administration, *Standards for Airport Marking, AC No. 150/5340-1J*, U.S. Government Printing Office, Washington, DC, April 29, 2005, pp. 1-2.

[xxxvi] U.S. Department of Transportation, Federal Aviation Administration, *Standards for Airport Marking, AC No. 150/5340-1J*, U.S. Government Printing Office, Washington, DC, April 29, 2005, p. 1.

[xxxvii] U.S. Department of Transportation, Federal Aviation Administration, *Design and Installation Details for Airport Visual Aids, AC No. 150/5340-30A*, U.S. Government Printing Office, Washington, DC, April 11, 2005, p. 3.

[xxxviii] U.S. Department of Transportation, Federal Aviation Administration, *Design and Installation Details for Airport Visual Aids, AC No. 150/5340-30A*, U.S. Government Printing Office, Washington, DC, April 11, 2005, p. 15.

[xxxix] U.S. Department of Transportation, Federal Aviation Administration, *Design and Installation Details for Airport Visual Aids, AC No. 150/5340-30A*, U.S. Government Printing Office, Washington, DC, April 11, 2005, p. 42.

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[xlv] U.S. Department of Transportation, Federal Aviation Administration, *Airport Snow and Ice Control Equipment, AC No. 150/5220-20*, U.S. Government Printing Office, Washington, DC, *Change 2*, 1994, p. 29.

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[xlvii] City of Concord, General Services Department, Public Properties Division, *Concord Municipal Airport Winter Operations Plan*, City of Concord, Public Properties Division, Concord, NH, November 1, 2004.

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